Secondary Treatment Facilities Plan

Volume V

Effluent Outfall

DRAFT REPORT

November 13, 1987

Secondary Treatment Facilities Plan

Volume V

Effluent Outfall

DRAFT REPORT

November 13, 1987

Notice to Reviewers

Attached for your review is Volume V Effluent Outfall, of the Secondary Treatment Facilities Plan.

To date the MWRA staff and Board of Directors have not reviewed this document but they have been briefed on its contents. No approval will be issued until the public review process is complete. The report is being circulated at this time to seek early review and comment by interested parties. Comments will be presented to the Board of Directors as they continue their review of the draft report.

Information in this report is current as of November 13, 1987.

Daniel K. O'Brien
Acting Director
Engineering Division
November 13, 1987

HOW TO USE

THE

SECONDARY TREATMENT FACILITIES PLAN

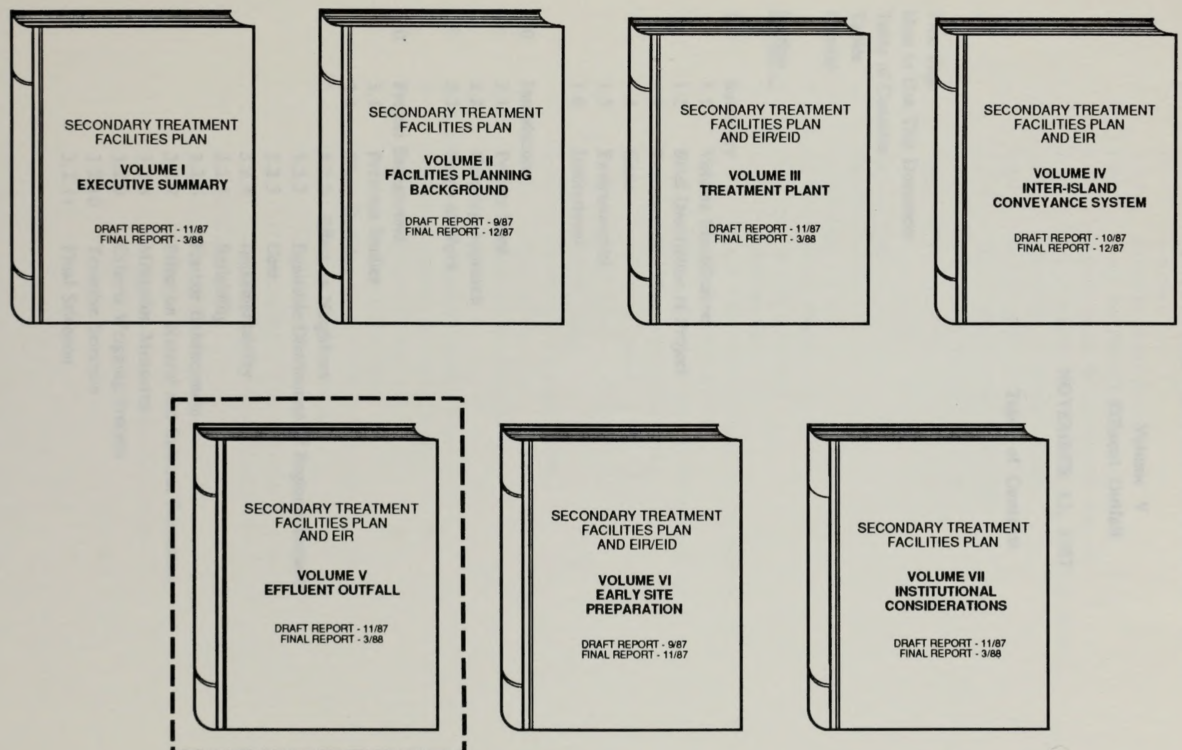
The Secondary Treatment Facilities Plan is organized into seven volumes.

The major components of the Secondary Treatment Facilities Plant are: Treatment Plan, Inter-Island Conveyance, Effluent Outfall, and Early Site Preparation.

The Secondary Treatment Facilities Plan document consists of a stand-alone volume for each of these components, as well as volumes for Facilities Planning Background, Institutional Considerations, and Executive Summary.

Each volume may be referenced to find complete planning information pursuant to that project component. The seven volumes are numbered as follows:

Volume I	Executive Summary
Volume II	Facilities Planning Background
Volume III	Treatment Plant
Volume IV	Inter-Island Conveyance System
Volume V	Effluent Outfall
Volume VI	Early Site Preparation
Volume VII	Institutional Considerations



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

DEER ISLAND
SECONDARY TREATMENT FACILITIES PLAN
VOLUMES

SECONDARY TREATMENT FACILITIES PLAN

Volume V
Effluent Outfall

NOVEMBER 13, 1987

Table of Contents

SECONDARY TREATMENT FACILITIES PLAN

Volume V
Effluent Outfall

List of Tables

SECONDARY TREATMENT FACILITIES PLAN

Volume V
Effluent Outfall

List Of Figures

Section 1

1.0 SUMMARY

1.1 VOLUME IDENTIFICATION

This is Volume V, Outfall Site Evaluation, Secondary Treatment Facilities Plan for the cleanup of Boston Harbor.

1.2 BRIEF DESCRIPTION OF PROJECT

The main objective of the Outfall Site Evaluation phase of the Secondary Treatment Facilities Plan is to select the location of the outfall terminus for the discharge of treated wastewater effluent from the newly-constructed MWRA treatment facility. The project involves assessments which will determine the appropriate location for the outfall and evaluations of the impacts of construction and operation of the facility on the marine resources of Boston Harbor and Massachusetts Bay.

The project was divided into three major components: physical oceanography to evaluate short- and long-term circulation patterns of Massachusetts Bay; chemical oceanography to determine background water quality conditions of the Bay; and biological oceanography to assess the existing biological conditions of the Bay and to evaluate the impacts of construction and operation of the treatment facility.

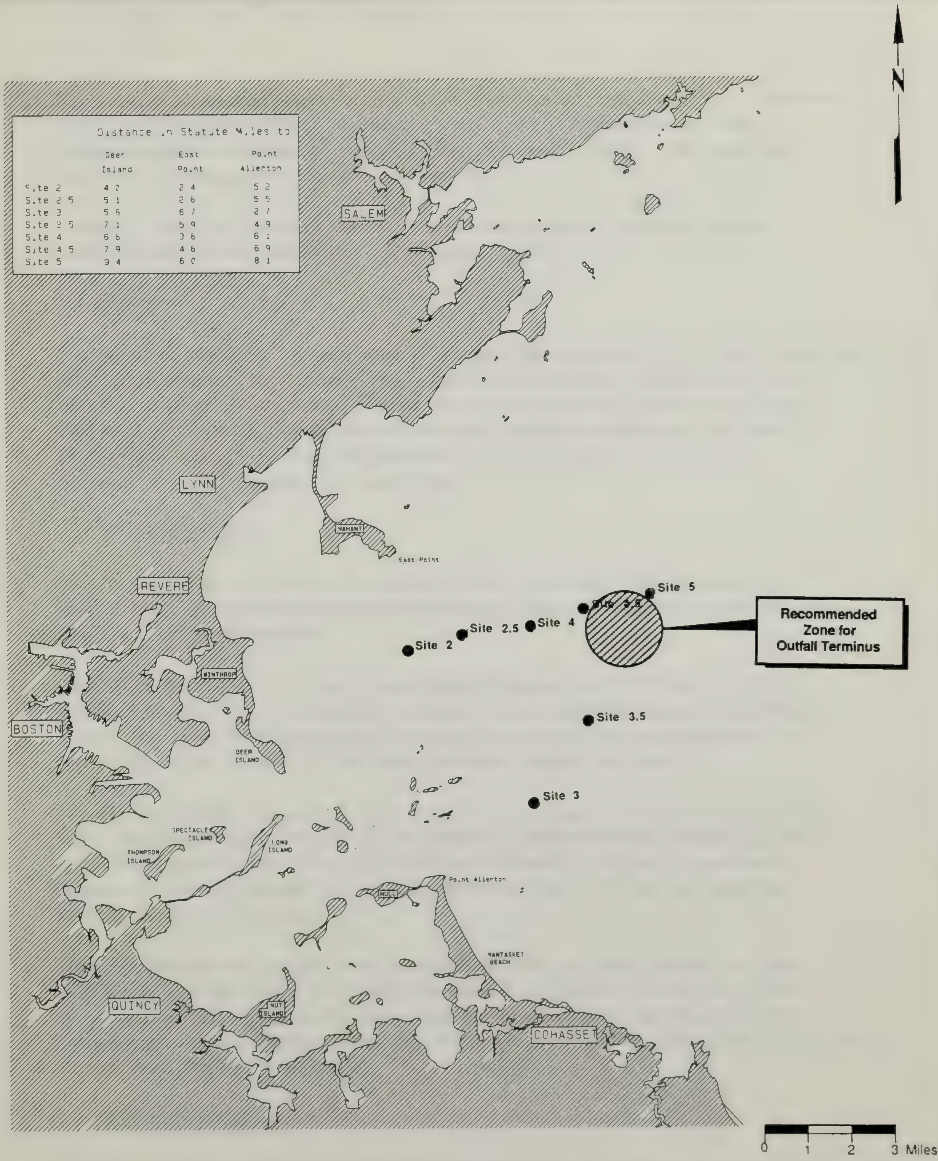
This Volume includes the results of these studies, as well as the investigations that were used to determine the optimal method of constructing the outfall and diffuser system.

This Volume covers the background information for the project as well as planning guidelines, discussion of outfall evaluation criteria affecting the outfall siting, existing conditions and field investigations, evaluation of outfall alternatives, a detailed evaluation of the recommended plan, and discussion of mitigation, institutional considerations, and the public participation compoment of the project. Extensive appendices document field investigations and provide other pertinent information.

1.3 RECOMMENDED PLAN

The recommended outfall location is in a region of Massachusetts Bay between 7.5 and 9.5 miles east-northeast of Deer Island. The area encompasses candidate outfall Sites 4.5 and 5, as shown in Figure 1.3-1.

The region represents the optimum mix of characteristics of good outfall sites. It is within the large-scale circulation patterns of Massachusetts Bay, and therefore provide the most robust long-term mixing. It is in a region of limited potential sediment accumulation, and thereby avoids problems associated with concentrating pollutants in bottom sediments. It is located away from intensely utilized near-shore resources, and thereby avoids the potential for disruption. And finally, it can all be reached by gravity within a reasonable time frame consistent with the spirit of the court-ordered target dates.



	Distance in Statute Miles to		
	Deer Island	East Point	Point Allerton
Site 2	4.0	2.4	5.2
Site 2.5	5.1	2.6	5.5
Site 3	5.8	6.7	2.7
Site 3.5	7.1	5.9	4.9
Site 4	6.6	3.6	6.1
Site 4.5	7.9	4.6	6.9
Site 5	9.4	6.0	8.1

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 1.3-1
RECOMMENDED OUTFALL LOCATION

The recommended outfall system consists of a deep rock tunnel, beginning at Deer Island and ending at a multi-riser diffuser. The diffuser consists of 80 individual vertical risers, equally spaced over a distance of 6,600 feet. Each riser will be capped with a multi-port 10-ft-diameter discharge head at the ocean floor.

In order to select the final site within the recommended region for the outfall terminus, detailed battymetric and geotechnical studies must be conducted.

1.4 COST

The cost of the outfall and diffuser system is between $388 million and $469 million, depending on the final location of the diffuser. This amount includes costs for: construction of the vertical access shaft at Deer Island; construction of the outfall tunnel using a tunnel boring machine; lining of the tunnel with precast concrete; disposal of tunnel spoils; drilling the risers for the diffusers; purchase and installation of diffuser heads; and a 35-percent allowance for engineering and contingency costs.

1.5 ENVIRONMENTAL

Construction activities associated with the outfall tunnel will have minimal environmental impact. Noise and traffic problems will be the only on-island environmental impacts, however they will be effectively mitigated.

The diffuser construction will entail a small degree of disruption of the benthic habitat, however the impact will be short in duration; rapid recolonization is expected. The diffuser structure will have minimal impacts on commercial activities such as bottom trawling, but proper design (with trawling in mind) would essentially mitigate this impact.

The discharge of wastes through the diffuser during facility operation may have minor impacts to the marine resources in the vicinity of the diffuser. Suspended solids contained in both the primary and secondary effluent in the discharge will settle. However, the amount of sediment buildup will be significantly less than tolerable levels, and would not adversely affect the benthic environment.

While in some cases the ambient levels of certain pollutants are above the state and federal criteria, the discharge itself will not meet EPA Water Quality Criteria in all cases. Some minor sublethal effects could occur under worst-case conditions, but the effects would be minimal under normal operating conditions. MWRA's commitment to source control should help to alleviate these problems in the future.

1.6 INSTITUTIONAL

Based on current knowledge of the geological conditions underlying Massachusetts Bay, it is anticipated that the outfall system can be constructed within a reasonable time frame. However, this depends on the final location of the diffuser, and thus may not be constructed

within the court schedule. Maintaining this deadline requires conducting geophysical surveys and final tunnel design as soon as practicable.

The permitting for the project will be extensive, requiring review from numerous federal and state agencies, including the Environmental Protection Agency, the Army Corps of Engineers, and various departments with the Massachusetts Executive Office of Environmental Affairs. Permitting must be initiated as soon as possible to remain within the construction schedule.

Extensive coordination of this project with other projects in the Boston area is required. The demand for resources, such as skilled workers and construction materials, will be at a premium thus careful planning is required.

Section 2

2.0 INTRODUCTION

2.1 PROJECT NEED

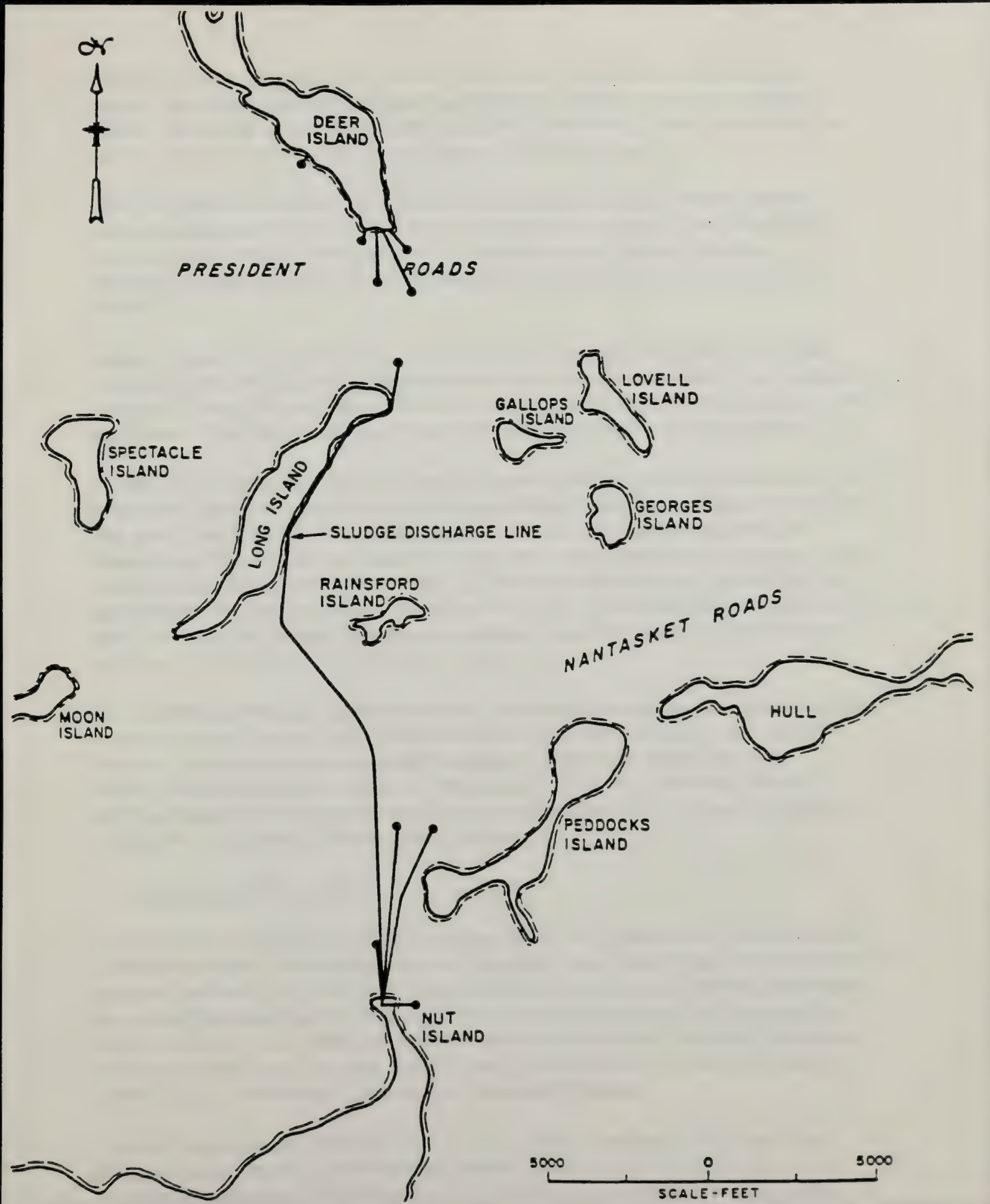
Since the time of the Revolutionary War, Boston Harbor has been considered a national landmark. The largest seaport in New England, it supports a variety of marine activities including shipping, fishing, boating and recreation. It encompasses an area of 47 square miles bordered by residences, commercial buildings, restaurants, marinas, beaches, industries and shellfishing flats. But since the settlement of Boston's shore areas, and most particularly since the City of Boston took possession of Deer Island for "sanitary purposes" in 1847, the Harbor has been the receiving water for all of the domestic, commercial and industrial wastewater and stormwater from the Boston metropolitan area.

Today, nearly 5,000 miles of sewers, conduits and pipes collect sewage from 1.9 million people and 43 metropolitan cities and towns and transport it to the area's two sewage treatment plants at Nut Island and Deer Island for treatment prior to discharge to Boston Harbor. Both of the plants are designed to provide primary treatment. Each plant provides disinfection of the primary effluent prior to discharge to the Harbor to reduce the levels of pathogenic bacteria. The disinfected effluent from Deer Island is discharged through two diffuser equipped outfalls into President Roads approximately 1,500-2,000 feet from Deer Island. Two additional relief outfalls are located 500-750 feet from Deer Island.

The disinfected effluent from Nut Island is discharged north through two main outfalls into Nantasket Roads approximately 4,500-5,000 feet from Nut Island. During periods of high flows and/or extremely high tides a third outfall extending about 1,500 feet north into West Gut side of Hingham Bay may be used. In addition, an emergency outfall extends 500 feet into the Hingham Bay side of West Gut.

The sludges removed from both plants are anaerobically digested and discharged into President Roads on the outgoing tide. Figure 2.1-1 illustrates the location of each of the treatment facilities and discharge locations. The combined discharge of primary effluent and sludge to the relatively shallow waters of Boston Harbor imposes a significant burden on the marine ecology in the waters surrounding the discharge. The discharge of floatable materials results in a significant deterioration in the aesthetic qualities of this vital resource. Because these discharges are but a few of the total discharges to Boston Harbor, and because scientific research to delineate the impacts of each discharge on the Harbor has been limited to date, the precise impacts of the primary effluent and sludge are difficult to quantify. However, these discharges are unquestionably very sizable and the materials being discharged are ecologically significant. Thus, every reasonable effort should be made to reduce these discharges.

The Deer Island treatment facilities were constructed in 1968, and the Nut Island treatment facilities in 1952. Both facilities have exceeded their useful lives and the levels of treatment provided are often less than optimal because of the unavailability of replacement equipment. Nut Island has recently undergone a rehabilitation of most of its major components. A similar rehabilitation is now underway for Deer Island. Rehabilitation of the existing



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 2.1-1 DEER ISLAND AND NUT ISLAND EFFLUENT AND SLUDGE DISCHARGE LOCATIONS

treatment facilities will optimize the levels of removal that these facilities can consistently provide. However, even the rehabilitated facilities cannot provide the levels of treatment desired. The design criteria and installed equipment of the existing primary facilities do not represent state-of-the art technology; therefore, they require replacement.

The 1972 Federal Clean Water Act requires that all municipal sewage treatment systems incorporate secondary treatment. Secondary treatment is more complex than the primary treatment that the flows at Nut Island and Deer Island currently receive, removing significantly higher levels of both organic materials and solids from wastewater (80 to 90 percent).

Like the Federal Water Pollution Control Act, the Massachusetts Clean Water Act requires promulgation of water quality standards for waters within the Commonwealth. The Massachusetts Division of Water Pollution Control has established these standards to satisfy the requirements of both acts. Thus, both Federal and State statutes require increased levels of treatment.

In 1982, the City of Quincy filed a suit against the Metropolitan District Commission (MWRA's predecessor agency) charging violations of laws prohibiting discharges into coastal waters and tidal waters, and violations of the common law of nuisance. As the suit progressed, the Massachusetts Water Resources Authority was created by the Massachusetts legislature. Almost simultaneously with MWRA's creation, the U.S. Environmental Protection Agency filed suit against MWRA alleging violations of the Clean Water Act. The Federal District Court found MWRA to be in violation and ordered the Authority to plan and construct new treatment facilities in accordance with an aggressive schedule (see Section 3.4.)

The need for upgraded and expanded treatment facilities to serve the Boston metropolitan area is clear: current discharges place a significant burden on one of the area's vital natural resources; the existing treatment facilities have long exceeded their useful lives; the existing treatment facilities do not reflect state-of-the-art technology and design; Federal and State statutes require enhanced levels of treatment; and the Federal Court has intervened and ordered an upgrading of the treatment facilities.

2.2 PLANNING APPROACH

This facilities planning study provides the foundation for the Massachusetts Water Resources Authority's program for the construction and operation of new primary and secondary wastewater treatment facilities at Deer Island. This planning has been approached with the understanding that the facilities planning effort must secure and sustain the acceptance and support of the diverse community, government and business interests that it affects. Therefore, the planning process was based not on technical strength alone, but also on the continual reconciliation of political, legal, environmental, economic and community interests.

A critical component of the facilities planning for secondary treatment facilities has been completed: the siting of the new treatment facilities. The decision-making process and the mitigation commitments made during that siting process are considered to be firm guidance for

the planning to be undertaken in this project. (See Section 3.2 for a description of the siting decision.)

The successful treatment of wastewaters from the Boston metropolitan area requires not only that enhanced treatment facilities be provided, but also that reliable, environmentally sound facilities be provided to manage the disposal of the residuals that are the direct by-products of wastewater treatment. The residuals management facilities plan is being conducted as a separate but concurrent study. The facilities needed and the sites being considered for residuals management are quite different from those needed for secondary treatment. However, the schedule for completion of the residuals management facilities plan is similar to the schedule for this plan. In addition, the approach and work plans for both of these planning studies recognize the synergistic relationship of these two plans. Thus, this planning study must be read with full cognizance of the residuals management facilities planning.

The facilities needed to provide secondary treatment include new primary and secondary treatment facilities located on Deer Island; a new conduit to convey the wastewaters from the existing Nut Island plant to Deer Island (inter-island conveyance facilities); and a new outfall to discharge the treated effluent into the ocean. In addition, a fourth component has been identified for the project: early site preparation. Early site preparation is defined as any construction activity that can start at an early date, i.e., before the completion of the on-island piers facilities needed to move the construction materials, equipment and personnel to the Deer Island site. The facilities planning for secondary treatment has thus been broken into four, stand-alone studies:

Treatment Plant, Volume III
Inter-Island Conveyance System, Volume IV
Effluent Outfall, Volume V
Early Site Preparation, Volume VI

To expedite the planning and review process, the facilities planning for secondary treatment has received a designation as a "major and complicated" project under the Massachusetts Environmental Policy Act regulations. The "major and complicated" project designation permits the environmental reviews to be concurrent with, and an integral part of, the facilities planning process. Thus, the documents being prepared to summarize the facilities planning are the same documents which will be used for environmental reviews.

The scope and sequencing of these facilities planning and environmental review activities are described in the following section.

2.3 SCOPE OF WORK

The purpose of the Secondary Treatment Facilities Plan is to evaluate the facilities needed to provide primary and secondary treatment, at a single facility to be located on Deer Island, of the wastewater conveyed through MWRA's North and South Systems. It will evaluate the

facilities needed to convey the South System flows from the existing Nut Island plant to Deer Island, as well as the outfall facilities needed to convey the effluent flows from Deer Island to a disposal point in marine waters. It will also identify and evaluate the construction activities which can occur as part of the Early Site Preparation effort prior to completion of the on-island piers and in preparation for the construction of the primary facilities.

The scope of work for the facilities plan is summarized below.

Project Management provides the overall project management required to ensure that the facilities plan is completed on time, within budget and with high standards of quality.

Data Collection inventories current and planned upgraded equipment and processes, assembles data regarding process equipment, mechanical, structural and hydraulic conditions, operating and maintenance characteristics, and expected useful life. Data Collection also will project flows and loadings, define the planning area, and provide a basis for evaluating further growth. This task will develop performance/removal criteria that will be used to balance the level of treatment required and the outfall location.

Facilities Engineering will characterize the wastewater to be treated, develop initial alternative planning and architectural concepts for Deer Island and ancillary facilities at Nut Island; complete site planning requirements; evaluate the adequacy of existing preliminary treatment facilities and evaluate unit processes for screening and grit removal; evaluate unit processes for primary treatment and residuals collection; evaluate unit processes for secondary treatment and residual collection; evaluate unit processes for disinfection; identify and evaluate the ability to control air emissions; establish alternative noise control methods and prepare a noise control plan for treatment plant operations and construction activities; determine the need for a pilot plant; evaluate the route and construction technology for locating and constructing the inter-island conveyance system and new effluent outfall; select an area for the outfall discharge which will meet water quality standards; characterize the soil and rock conditions under the proposed facility and related wastewater conveyance systems; identify and evaluate treatment processes; evaluate the reliability and flexibility of each of the treatment alternatives; estimate capital costs for the selected facilities and equipment; identify and estimate utility needs; identify operator needs and develop a preliminary operations plan; outline the requirements to operate the existing plants during construction; and provide pre-construction planning.

Institutional tasks include development of an annual cash flow projection required for the construction of the facilities; identification of the financial impacts of the recommended plan on MWRA's customers; identification of proposed changes or additional laws, regulations, legislative restrictions and agreements that may affect the implementation of the facilities plan; description of potential permit and regulatory agency approval requirements and preparation of a preliminary permitting plan; and implementation of a full-scale public participation program.

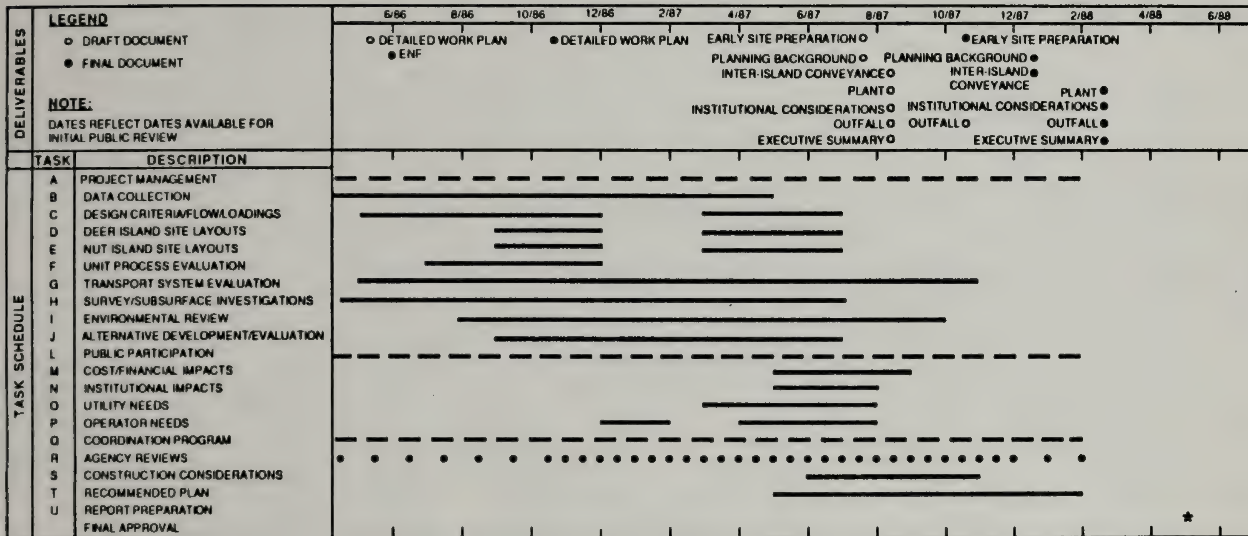
Recommended Plan is the preparation of the Secondary Treatment Facilities Plan and development of an implementation schedule/plan for each design and construction phase, as well as the

coordination of, and response to, reviews by regulatory agencies.

A more detailed outline of each work task will be found in Appendix A. Figure 2.3-1 illustrates the general flow of the planning activities.

SCHEDULE OF MAJOR DELIVERABLES

VOLUME	NAME	DRAFT REPORT	FINAL REPORT
I	EXECUTIVE SUMMARY	9/87	2/88
II	PLANNING BACKGROUND	6/87	12/87
III	WASTEWATER TREATMENT PLANT	9/87	2/88
IV	INTER-ISLAND CONVEYANCE SYSTEM	8/87	12/87
V	EFFLUENT OUTFALL	11/87	3/88
VI	EARLY SITE PREPARATION	7/87	10/87
VII	INSTITUTIONAL CONSIDERATIONS	9/87	2/88



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 2.3-1
SECONDARY TREATMENT FACILITIES
PROJECT PLANNING SCHEDULE

[illegible]

Section 3

3.0 PROJECT BACKGROUND

3.1 PREVIOUS STUDIES

Since 1900, there has been concern over water pollution problems in Boston Harbor. The State legislature initiated six investigations into the condition of the Harbor between 1900 and 1939. The last of these investigations resulted in the construction of the present Deer Island Treatment Plant which was completed in 1968.

But even as the Deer Island Plant was completed, the Federal Water Pollution Control Administration released a report on the impact of pollution on the Harbor's waters citing recreational, economic and biological impairment. The report generated increased interest in addressing pollution problems and at the first Enforcement Conference on Boston Harbor, state and federal officials agreed on the formation of a technical study group to explore measures for pollution abatement. The recommendations and agreements which grew out of these conferences, in conjunction with the mandates of the Federal Water Pollution Control Act and the Massachusetts Clean Water Act, have formed the framework for attacking pollution in Boston Harbor.

The process of identifying long-term wastewater treatment needs and solutions for the greater Boston Metropolitan area began in 1973 when the Metropolitan District Commission (MDC) began work on wastewater engineering and management planning for Boston Harbor. (Table 3.1-1 provides a list of planning reports for wastewater treatment in Boston Harbor.) The Eastern Massachusetts Metropolitan Area Wastewater Management and Engineering Study (EMMA) was conducted to ascertain what repair, replacement, extension, and expansion of facilities were required to provide adequate sewage treatment for the next fifty years.

In the fall of 1976, following publication of the EMMA Study, EPA's regional office requested that an Environmental Impact Statement (EIS) be prepared before any facilities planning. When the draft EIS was completed in 1978, it resolved the controversy regarding satellite facilities and proposed the consolidation of all planned treatment facilities on Deer Island.

A few months prior to the publication of the EIS, the MDC had responded to the 1977 amendments to the Clean Water Act which provided for a waiver of secondary treatment. If a waiver were granted, much of the construction contemplated in the EMMA Study would be deferred, at least until expiration of the modified permit, and perhaps indefinitely if the permit were renewed. Nevertheless, because regulations pertaining to the waiver process required that facilities plans to provide secondary treatment be prepared concurrently with the waiver process, the MDC, following release of the draft EIS, began preparation of a facilities plan.

Starting in 1983, the EPA and the Commonwealth jointly prepared the Supplemental Environmental Impact Statement/Environmental Impact Report (SEIS/DEIR) on the Site Options Study. The purpose of this document, which augmented the EIS evaluations done on the EMMA Study, was to review the environmental impacts of the Site Options Study alternatives, as well as other alternatives within the context of both the National and Massachusetts Environmental Policy Acts. The SEIS/DEIR started with twenty alternatives and selected seven treatment plant siting

alternatives for final review. The MWRA later reinstated one alternative for final review. Four alternatives involved secondary treatment and four involved primary treatment. The alternatives considered included locating all treatment facilities at Deer Island, all treatment facilities at Long Island, or combinations of plant locations that used Deer, Long, and Nut Islands together in various configurations.

Also in 1983, almost five years after MDC filed a preliminary application for waiver of secondary treatment, the application was tentatively denied by EPA. Because of intervening regulatory developments, MDC was entitled to file an amended application. Shortly thereafter, MDC notified EPA of its intent to do so, and a scope of study was agreed upon, including water sampling to be performed in the summer of 1984. Final submissions were made by MDC in October, 1984.

Although the cost implications of secondary treatment and the ultimate rate-payer impacts promoted pursuit of the waiver application over several years, the waiver application exacerbated two major problems in planning the cleanup of Boston Harbor. First, as long as the "level" of treatment (secondary vs primary) was uncertain, the nature and size of new treatment facilities were impossible to fix for planning purposes. Second, planning for sludge management was frustrated because of the disparity in both the tonnage and character of sludge from secondary treatment as opposed to primary treatment. On March 29, 1985, EPA rejected MDC's amended Section 301 (h) waiver application.

The Massachusetts Water Resources Authority assumed control of the MDC sewerage system on July 1, 1985. The MWRA made the decision to proceed as fast as possible with the secondary treatment program for Boston Harbor, notifying EPA that they would choose a preferred alternative for focused analysis by early July, 1985.

Table 3.1-1 lists planning projects undertaken for Boston Harbor wastewater treatment since the 1976 EMMA study.

3.2 SITING DECISION

The MWRA determined that the seriousness of the siting decision to be made and the newness of the MWRA as a participant in the decision process merited a thorough review of the material presented in the SDEIS/DEIR and comments made pursuant to that document, as well as a consideration of all additional information being developed in response to the issues raised by those comments.

The MWRA began its site selection process by reviewing the six criteria established in the SDEIS/DEIR (i.e., cost, effects on natural and cultural resources, effects on neighbors, harbor enhancement, implementability, and reliability). The MWRA voted to adopt these six criteria, but determined that two additional criteria should be adopted as well: equitable distribution of regional responsibility; and mitigation measures. The first of the new criteria, equitable

TABLE 3.1-1

SUMMARY OF PLANNING REPORTS FOR WASTEWATER TREATMENT IN BOSTON HARBOR

1976, March	Eastern Massachusetts Metropolitan Area Wastewater Engineering and Management Plan of Boston Harbor, Metcalf & Eddy, Inc.
1976	Non-structural Controls for Combined Sewer Overflows, Environmental Research and Technology, Inc.
1976, May	Joint Task Force Report on Major Manned MDC Facilities Located in the Greater Boston Area, EPA Region 1
1976, July	Wastewater Management Planning: Boston Metropolitan Area Phase I Study, Urban Systems Research and Engineering, Inc.
1976, July	Phase I Engineering Report Boston Case Study, Kennedy Engineers, Inc.
1976, August	Phase I Final Report on Greater Boston Water Quality Issues in Planning for Pollution Control, Verlex Corp.
1976, November	Boston Metropolitan Area Waste Treatment Feasibility Study, Stone & Webster Engineering Corp.
1979, January	Wastewater Treatment Facilities Planning in the Boston Metropolitan Area - A Case Study, Kennedy Engineers, Inc.
1979, September	Application for Modification of Secondary Treatment Requirements for Discharge into Marine Waters of Boston Harbor and Massachusetts Bay for its Deer Island and Nut Island Wastewater Treatment Plants, MDC
1980, December	MDC Headworks Grit and Screenings Removal Systems - Preliminary Report, Whitman and Howard, Inc.
1982, June	The Commonwealth of Massachusetts Nut Island Wastewater Treatment Plant Facilities Planning Project, Phase I, Site Options Study, Volumes I and II, Metcalf & Eddy, Inc.
1982	Nut Island Wastewater Treatment Plant Immediate Upgrading, Metcalf & Eddy, Inc
1984	Deer Island Facilities Plan, Havens & Emerson/Parsons Brinkerhoff

TABLE 3.1-1
(continued)

SUMMARY OF PLANNING REPORTS FOR WASTEWATER TREATMENT IN BOSTON HARBOR

1984	Supplemental Draft Environmental Impact Statement and Draft Environmental Impact Report, EPA
1984	Application for a Waiver of Secondary Treatment for the Nut Island and Deer Island Treatment Plants, Metcalf & Eddy, Inc.
1985, November	Final Environmental Impact Report on Siting of Wastewater Treatment Facilities for Boston Harbor, Camp Dresser & McKee, Inc.
1985, December	Final Environmental Impact Statement on Siting of Wastewater Treatment Facilities for Boston Harbor, EPA

distribution of regional responsibility, was viewed as subsuming the "fairness" issue which had been the subject of substantial commentary on the SDEIS/DEIR. The second new criterion, mitigation measures, was adopted to ensure consideration of both environmental and non-environmental mitigation and to permit the MWRA to fully respond to mitigation concerns during its siting deliberations.

The MWRA next reviewed the site options to be considered. It voted to examine the seven site alternatives proposed at the conclusion of the SDEIS/DEIR (all secondary Deer Island, split secondary Deer Island and Nut Island, all secondary Long Island, split secondary Deer Island and Long Island, all primary Deer Island, split primary Deer Island and Nut Island, split primary Deer Island and Long Island) and, in response to the Secretary's Certificate of Adequacy on the SDEIS/DEIR, also voted to reinstate for evaluation one site option that had been dropped from consideration at the close of the SDEIS/DEIR (all primary Long Island).

The MWRA then proceeded to an evaluation of each site alternative in the context of the criteria selected. A number of consultants were engaged to assist in the collection, evaluation, and presentation of pertinent materials to the Board members at their publicly held meetings. Oral and visual presentations on each of the eight criteria were given, followed by questions and discussions which refined the issues to be addressed and identified additional information to be obtained. Second presentations and discussions were held on seven of the criteria, and a third round of review and debate occurred on the criterion of cost. As a consequence of these deliberations, further presentations and discussions were held on several sub-topics that were of particular interest or thought to require additional attention.

In addition to its own consultants' presentations, the MWRA heard and discussed presentations by the Regional Administrator of EPA, by representatives of the Executive Office of Environmental Affairs and the Department of Environmental Quality Engineering, and by the technical and legal representatives of the Town of Winthrop and the City of Quincy. In all, the MWRA listened to and discussed at some length, 23 separate presentations on 13 different topics applicable to the preferred alternative siting decision.

A summary of all the siting presentations given and the Board's discussions was provided to the Board members for further review and analysis prior to the vote on the tentative preferred alternative site selection. Copies of letters from officials and the public concerning the siting decision were either provided to Board members during the ongoing deliberations or were included in the siting summary notebook. The Board members also visited the sites being considered.

The following sub-sections contain summaries of the MWRA's deliberations concerning each criterion as it applied to the site selection to be made. Throughout the process of selecting the tentative preferred alternative site, the MWRA evaluated and compared the information received in light of the criteria adopted. It observed interrelationships among the criteria and discussed the value to be accorded to the criteria in the context of various site alternatives. The last sub-section summarizes the way in which the criteria weighed one against the other with respect to the sites considered.

3.2.1 EFFECT ON NEIGHBORS

The purpose of this criterion was to address treatment facility impacts on the neighbors of the treatment plant. Factors evaluated by the MWRA were traffic, noise, odor, visual effects, property values, and health and safety issues. An exploration of the numbers of persons potentially impacted by the proposed primary, secondary and split treatment plant site options was conducted. Distinctions were made between those who might be voluntarily exposed to the negative impacts and those who resided nearby and had no choice with respect to being impacted, with greater value being accorded to the latter. Consideration was also given to the potential impact of the treatment plant on those working, living or staying at either the hospital on Long Island or the prison on Deer Island. Weight was attached to the fact that persons in the institutions would be closer to the source of impacts for longer continuous periods and would be exposed to a higher degree of impact at any given time. Concern about the effects on these populations served in part to motivate the MWRA to analyze in more detail the "footprints" that could be accommodated on Long Island and on Deer Island and the need for and feasibility of mitigative design concepts, buffers, and/or the relocation of the respective institutions. Also considered was the exposure to impacts over a longer period of time as would be the case for most of the residential neighbors.

<u>Traffic</u>

Traffic access roads were reviewed for capacity and for anticipated peak and average use with and without the utilization of barging and busing. The MWRA learned that the greatest numbers of persons would be affected along the Winthrop access routes, but that a substantial number of persons would be affected along the East Squantum access routes as well. The fewest persons would be affected if the Quincy Shore Drive route to Long Island were available, but there were questions of implementability and structural feasibility that would have to be resolved in order to use that route. The degree of negative impact on the various roads was considered to be roughly the same for the various site alternatives.

A great deal of consideration was given to barging, with the recognition that it was required in order to sufficiently mitigate the traffic impacts that would be caused during construction. Implementability issues with regard to barging -- such as Coast Guard regulations and the construction of piers -- were explored, as were the costs of barging. A determination was made that the same requirements for barging applied to whichever site alternative was selected, and therefore the concerns surrounding barging as a mitigation measure for the alleviation of traffic impacts on neighbors were found to be not site-determinative.

Also reviewed were the potential mitigation measures of ferrying workers to decrease traffic, and rehabilitating or replacing access bridges to accommodate heavy trucking. Implementing each of these measures appeared to pose a relatively similar degree of difficulty between sites and was not found to be an absolute deterrent. The cost of bridge repair or construction did differ between sites and was explored in greater detail by the MWRA in its concern for the issue of traffic impacts and the need to alleviate them. It was determined that it would be most costly to repair, replace or construct new bridges for access to Long Island. Assuming a heavy reliance upon barging and taking into account the above factors, the MWRA

concluded that the traffic impacts were significant but manageable with respect to all sites, and that this was not a site-determinative factor.

Noise

The information on noise contained in the SDEIS/DEIR was reviewed, and the concerns of the Town of Winthrop with respect to the adequacy of that information and the possible site-determinative nature of construction noise impacts were explored. Berms and temporary noise barriers were also discussed. The MWRA received a detailed letter from, and heard a presentation by, Winthrop's technical consultant. It further pursued additional noise information through the technical advisory group meetings and shared the ongoing work done by EPA's technical consultant. An update of this work was presented to MWRA by EPA shortly before MWRA's siting decision. The information on noise gathered and presented by EPA and adopted by MWRA for its tentative preferred alternative site selection indicated that although noise levels at Deer Island would result in greater impact to neighbors, particularly the close neighbors at the House of Correction, the level of construction noise at either site was at acceptable levels or could be sufficiently mitigated so that it was not a site-determinative issue.

Odor

The impact of odors, taking into consideration source, distance, population density, and potential for occurrence, was also evaluated. In addition to evaluating the effect of odors on nearby residences and the existing institutions, the MWRA considered the effect of odors on potential recreational users. It was determined that there might be intermittent effects on neighbors at either site with a potentially substantial effect on recreators at Long Island Head, given the seasonal wind patterns and projected siting plans.

The use of covered tanks to mitigate odors was explored. The MWRA balanced the mitigating effect of covered tanks against the operation and management difficulties that had been experienced at other plants utilizing covers and also considered the additional cost required to employ covered tanks.

After reviewing odors and their potential impact on any of the sites considered, the MWRA determined that odor control was a paramount concern in the design of the treatment plant and that stringent odor controls would be utilized no matter where the treatment plant was located. Having decided this, and having reviewed the odor impact information, the MWRA concluded that odor and its control posed somewhat different problems at each island but balanced out sufficiently so as not to be a site-determinative issue between Long Island and Deer Island.

Odor impacts were found to have some significance, however, in the choice between all secondary options that retained the existing institutions and those secondary options featuring removal of the hospital or House of Correction. The options featuring retention of the existing institutions were considered less desirable because the ability to design the treatment plant with odor sources farther away from residential or recreational uses was substantially reduced at the more constrained sites. The retention of the institutions also increased the number of

persons impacted and degree of severity of impact with respect to the persons living, working or staying in the institutions.

Visual Effects

It was determined that a treatment plant on either island would have a negative impact on persons in the existing institutions due to proximity. With respect to residential neighbors, it was determined that if the institutions remained, there would be a greater negative impact from a treatment plant on Deer Island. If the House of Correction were removed, however, modifying landforms and landscaping could be used to screen the treatment plant from most residences.

Property Values

The effect on property values of the construction and operation of the treatment plant was addressed. Comparisons of affected communities with respect to fair market value, past appreciation, turnover rates and anticipated changes due to treatment plant construction and operation were reviewed. It was generally concluded that, no matter which site option was selected, property values probably would not decline during successful plant operation. However, there was discussion that there may be a decline of property values for communities near the treatment plant during construction but that these values would likely rebound fully after completion of construction. Also discussed was a projected possibility that property values around Deer Island might not fully rebound after construction. However, it was also deemed possible that the substitution of a carefully constructed and well-run treatment plant on Deer Island might raise values in the neighboring communities higher than they would be with the continuation of the existing plant operation. On the whole, property value impacts were determined not to be site-determinative, but a matter to be addressed through mitigation once a site was selected.

Health and Safety

Health and safety concerns of the community -- such as traffic impacts on schools and the elderly, chlorine delivery, air quality reduction from traffic or the facility operation -- were examined and not found to be site-determinative factors.

Summary of Effects on Neighbors

Most of the effects considered within each of the above sub-categories of effects on neighbors were found to be roughly equivalent when applied to the various site options. Although there were perceived imbalances of effects under some of the sub-categories, imbalances against one site under one sub-category tended to be neutralized by imbalances against another site in another sub-category. For example, imbalances found against the use of Long Island for either all secondary or mixed alternatives due to the additional cost of the traffic mitigation measures of repairing or replacing access bridges tended to balance out against the additional cost that might be required for noise mitigation on Deer Island, particularly if the House of Correction was not removed.

Similarly, the imbalance against Long Island caused by the determination that more substantial odor effect was likely on potential recreators was balanced against the possibility for greater negative visual impacts on residential neighbors from a treatment plant on Deer Island if the House of Correction was not removed. In sum, when all the effects were weighed within the sub-categories and the total effects of each sub-category were weighed one against the other, the MWRA concluded that the criterion of effects on neighbors, as a whole, was not site-determinative.

3.2.2 EQUITABLE DISTRIBUTION OF REGIONAL IMPACTS

Equitable distribution of regional impacts was adopted by the MWRA as an additional criterion in response to the issues of fairness raised in the comments on the SDEIS/DEIR. The criterion brought into the decision process considerations of how many and what kind of impacts a community might already bear from proximity to regional facilities other than the contemplated treatment plant. For example, impacts on Winthrop from Logan Airport, the Deer Island House of Correction and the current Deer Island treatment plant were reviewed, as were the effects on Quincy of the existing Nut Island treatment plant and flight patterns from Logan Airport. Distinctions were made between regional uses that provide little benefit to the community impacted (such as Logan Airport vis-a-vis Winthrop) and those regional facilities which daily serve a number of residents of the impacted communities (such as MBTA stations in Quincy). It was further noted that the impact from the latter use was mitigated by the existence of a local-aid fund which provides some monetary reimbursement to host communities.

The consideration of regional use burdens on potentially impacted communities had two applications in the preferred alternative siting decision. First, there was an assessment of whether or not the cumulative regional burdens on any one particular community would be so excessive if the treatment plant were sited nearby as to require, without regard to any other criteria, that the treatment plant be sited elsewhere. One decision-maker concluded that the cumulative and long-term burdens imposed on Winthrop currently and in the past required a decision to site the treatment plant at a location other than Deer Island. Other decision-makers decided that the degree of unfairness did not rise to the level of unilaterally precluding the siting of the treatment plant on Deer Island.

The second way in which the criterion of equitable distribution of regional impacts was applied was to broaden the scope of factors to be considered in assessing effects on neighbors and in determining the nature and degree of mitigation measures to be undertaken. As to the former, the impacts of other regional uses were evaluated not only separately, for their effect on the community, but as they might combine with the noise, odor, and other impacts of the proposed treatment plant.

In assessing the impact of regional facilities on the various communities, the MWRA concluded that the choice of any of the alternative site options was unfair to whichever of the communities were impacted, by virtue of the burdens to be borne by those particular communities on behalf of so many other communities. When contrasting the relative regional burdens between the impacted communities, some decision makers noted that the greatest share of burdens for

regional impacts was already borne by the City of Boston and that Boston's burdens would be increased whichever option was chosen. Between the City of Quincy and the Town of Winthrop, the MWRA concluded that the greater number of regional burdens borne by Winthrop made it more unfair to Winthrop to locate the plant on Deer Island than it was unfair to Quincy to locate the treatment plant on Long Island.

3.2.3 COST

From the outset of its deliberations, the MWRA considered cost to be an important criterion. One of the first tasks the MWRA undertook was to closely examine the previous cost estimates which had been included in the 1982 MDC Site Option Study and the SDEIS/DEIR. Those cost estimates and a new set of estimates prepared by MWRA's consultant were analyzed and discussed both as to the absolute dollar figures presented and as to the relative differences in costs between sites.

Following the initial presentation to and discussion of these figures by the MWRA, consensus was reached by the various cost estimators which reduced the range of difference among them by half. The MWRA reviewed the original figures, the new figures, the basis for each and the rationale for the differences. It recognized that the figures could be firm to only a certain degree, given that a site was being selected prior to any facility design being undertaken. The MWRA chose to consider the higher figures in the range as better representing the most conservative case for design and construction needs and choices, including but not limited to greater assurances of reliability through increased redundancy and mechanical backup.

At each stage of development of the cost figures, the MWRA determined whether the differences changed the ranking or rating of the site alternatives or the relative differences between the alternatives appearing in the SDEIS/DEIR. As to the first two stages of development in cost estimates described above, the MWRA concluded that the ranking or rating of alternatives remained the same and the relative difference between the sites remained constant no matter which estimates at which level of refinement were used.

However, as the deliberations of the MWRA with respect to the other criteria continued, it became evident that cost was closely intertwined with assessments of those criteria and constituted an important factor for each item evaluated. As a result, further discussion and inquiry on costs were undertaken by the MWRA, and a third and more detailed cost analysis was produced. The resulting figures were reviewed and discussed by the MWRA. It was determined that while the new figures narrowed the difference in cost between some of the options involving Long Island and some of the options involving Deer Island, it did not change the ranking of any of the site alternatives.

The MWRA also developed and discussed a comparison of costs between Deer Island and Long Island with and without the existing institutions. The MWRA concluded that in all cases, it was less costly to construct the treatment plant on Deer Island as compared to constructing it on Long Island. It further determined that it was less costly to construct the treatment plant on either of the islands without the respective existing institutions being present.

3.2.4 IMPLEMENTABILITY

The MWRA utilized the implementability criterion to assess how quickly and how predictably the treatment plant could be completed at each of the alternative sites. This included a review of the requirements for and potential impediments to obtaining the real estate necessary for the construction of the treatment plant under the various alternatives. After examining the ownership and the means by which that ownership could be transferred, the MWRA concluded that obtaining the required land under all the options was roughly equal in terms of the legal steps to be taken and the likelihood of success.

The MWRA also reviewed the various permits, licenses and approvals that would be required from federal, state and local authorities in order to build the treatment plant under the various site plans proposed. It found that most of the state and federal permits required were equally applicable to Deer Island and to Long Island. It noted that burial grounds and archaeological/historical properties were a significant issue with respect to Long Island and would probably require extensive mitigation efforts, but also took into account that Deer Island had historic resources that might require consultation with authorities and possible mitigation. Similarly, the MWRA examined the conclusion of the SDEIS/DEIR that the permit issues surrounding burial grounds principally impacted Long Island, but also noted the possibility that they might be involved with Deer Island as well. With regard to the loss of historical or archaeological resources, the MWRA gave weight to the fact that the necessary consultation, mitigation and approval process for whichever island was selected could be engaged in concurrently with the facility planning and design process for the treatment plant, and would not greatly delay the construction of the facility. It was also considered important that this approval process, while requiring consultation and mitigation, could not prohibit the construction of a treatment plant on either island.

Further implementability issues that might apply to only one of the islands, or might be more difficult on one island as compared to the other, were examined. These included wetlands, order of Conditions, bridge construction, barrier beaches, opening of Shirley Gut, air quality questions, possibility of contaminated dredge spoils, existing grit and screenings, hospital relocation and House of Correction relocation. The first three of these issues were thought to have more certain application to Long Island but were considered to have possible application to Deer Island as well. The middle three issues were looked at as possibly raising additional or more difficult issues in the case of Deer Island. Air quality issues were discussed with EPA, and further information obtained by the EPA indicated to the MWRA that the treatment plant could be located at either island without violating national ambient air quality standards for air pollution under the configurations being considered by MWRA and by EPA.

Implementability of relocating the existing institutions on Deer Island and Long Island was scrutinized very closely by the MWRA. The MWRA heard and considered presentations by legal counsel to the City of Quincy and the Town of Winthrop on the need for and comparative legal difficulty of relocating the institutions. The MWRA also received and evaluated communications from the Governor of the Commonwealth, the Mayor of the City of Boston and the Speaker of the Massachusetts House of Representatives. The MWRA concluded that, as to real estate and permit approval issues, the various site options balanced out with respect to implementability. The

removal of the House of Correction from Deer Island, however, was felt by the MWRA to be more feasible than removal of the Long Island Hospital, considering the commitments made by the authorities who would be in a position to implement the respective relocations.

3.2.5 RELIABILITY

The MWRA viewed reliability as the concept of enhancing the overall integrity of the waste treatment system. Information was received on such factors as minimization of detrimental consequences of outages, operational capabilities during and after construction, managerial enhancement and technological reliability. Particular issues of reliability were explored in more detail. The performance of a secondary treatment system was reviewed at some length with stress on the need for proper design to handle such things as variable loads and intake of septage to prevent a malfunctioning of the system which would result in partially treated sewage being released into the harbor through a short outfall. The reliability of tunnels was reviewed, and the use of round versus rectangular clarifiers was discussed. Also considered was the need for backup in the case of catastrophic outages.

With regard to clarifiers, the Board heard that circular clarifiers were considered more reliable by some and that use of those clarifiers would require a greater acreage and expenditure to install, but it also heard that a comparable degree of reliability could be provided by rectangular clarifiers, which use less space and are less costly. The MWRA determined that either type of clarifier could be utilized under the various site options being considered.

The greater or lesser use of tunnels under any particular site option was considered to be an insignificant factor since it was determined that reliability of tunnels could be assured through proper design and maintenance during construction and operation. There was a recognition that those site options with split plants would provide greater reliability in the case of catastrophic outages, but this fact was determined to be offset by the consideration that such outages could be expected to occur at very infrequent intervals and that the ability to achieve reliability at split plants would be more costly because of the need to provide two sets of administration and staffing.

In assessing the various site options in light of reliability factors, the MWRA concluded that, while reliability was a very important consideration in constructing and operating the wastewater treatment plant, it was not a determinative factor in selecting site options between Long Island and Deer Island. Reliability was viewed by the MWRA, however, as a very important factor in its relationship to impact on neighbors. Any reduction of efficiency or increase in operational malfunctions would potentially create greater negative impacts, such as odors, on the neighborhood. It was also recognized and considered an important factor that the capital cost of the secondary treatment plant would be greatly increased by the design and engineering which would be necessary to protect against the greater unreliability inherent in a constrained site. Also, higher operational and maintenance costs would have to be anticipated as a result of the more complex design that would be required.

Weighing all these factors, the MWRA concluded that greater reliability would be obtained in any of the secondary treatment plant options if the respective existing institutions were

removed and, conversely, that reliability would be severely impacted if the secondary treatment plant was built without removing the respective institutions. In any other regard, reliability was considered to be equally obtainable at all site alternatives considered and therefore not site-determinative.

3.2.6 HARBOR ENHANCEMENT

The MWRA's view of harbor enhancement incorporated compatibility of the proposed treatment plant with attainment of the harbor's potential. The MWRA reviewed the site alternatives not only with respect to how each site option might serve as a source of impact on the Harbor but also as to how each option might serve as an opportunity for achieving the objectives listed. This information for the site options -- as they related to one another and to the Harbor as a whole -- was then considered.

Certain concerns of the MWRA were further explored. The potential for recreational use of Deer Island was reevaluated and discussed. As a result, the MWRA accorded greater weight to the recreational potential of Deer Island than had been previously assigned to it in the SDEIS/DEIR. The MWRA concluded that the recreational potential of Deer Island and of Long Island, absent any development, was similar in a number of ways with many of the same types of activities potentially available. Two differences were found to favor the preservation of Long Island's recreational potential, however. The first was the greater potential for public swimming beaches at Long Island. The second was the wilderness experience derived from the wild vegetation in the undeveloped parts of Long Island which, once destroyed, could not be recreated elsewhere.

The two islands were also reviewed for compatibility of recreational use with a treatment plant present. If the existing hospital were retained along with the treatment plant, Long Island would lose the significant recreational potential of Long Island head but might retain its barrier beaches, whereas if the existing House of Correction were retained, Deer Island might be able to encompass a small naturalized park located at Deer Island head. If neither existing institution remained along with the treatment plant, a park at Long Island head and an environmental study area in the southwest of Long Island could possibly be preserved, while at Deer Island, a neighborhood park and a regional park could be created and the natural beaches preserved.

It appeared to the MWRA that the quality of recreation on the islands -- co-existent with a treatment plant but without the existing institutions -- was higher for Deer Island than Long Island. At Deer Island, existing or man-made landforms could screen recreational areas from nearby receptors. At Long Island, the treatment plant would be highly visible, and the wind patterns might carry the odors over Long Island head a significant amount of the time. In balance, the MWRA felt that greater recreational potential for the harbor would be available by building the treatment plant on Deer Island rather than Long Island with or without the existing institutions, but particularly in the latter case.

The MWRA also considered implementability of recreational plans. It was noted that Long Island was physically ready to be developed for recreational use almost immediately if no treatment plant were sited there, but that a much longer time would elapse if recreational use had to wait until a treatment plant was operational on Long Island and the Deer Island treatment plant subsequently removed. The availability of funds for recreational development of Long Island as an already established priority in the Boston Harbor Islands Park system enhanced the likelihood of recreational development of Long Island in the near future.

In assessing the visual effect of the various treatment plant site options, it was determined that the primary and secondary treatment plant options at Long Island were deemed to produce the most radical changes to the natural terrain and to impact the most negatively on the harbor as a whole.

Having reached the above conclusions and having evaluated the information contained in the SDEIS/DEIR, the MWRA concluded that harbor enhancement would be promoted by the preservation of Long Island as a potential park resource and, conversely, that the harbor would be diminished both visually and for recreational purposes, if the treatment plant were constructed on Long Island.

3.2.7 EFFECT ON NATURAL AND CULTURAL RESOURCES

The MWRA examined the natural and cultural resources that would be impacted by each of the site option alternatives. In addition to the information contained in the SDEIS/DEIR, summaries further distilling the information and updated reports of ongoing evaluations of the sites by the Massachusetts Historical Commission were heard and evaluated. The MWRA not only considered the number and significance of historical, cultural and archaeological structures and sites, but also the degree of mitigation that might be required if such places and things were disturbed. The possible effect of any mitigation measures on duration and cost of construction was then assessed. The MWRA also gave some weight to the nomination or intended nomination of those items to the National Register of Historic Places.

The MWRA took into account the number of archaeological sites in existence, the rarity and integrity of such sites, the contribution of such sites to an understanding of our history, and the quantity of material contained in the sites. It was noted that no archaeological sites had been uncovered at Deer Island, but the MWRA also took into account that there had not been as thorough a survey of parts of Deer Island as there had been for the whole of Long Island. Nevertheless, in reviewing the five prehistoric sites uncovered at Long Island, the MWRA determined that their preservation deserved stronger consideration in the choice of a site.

With regard to cemeteries, the MWRA contrasted the existence of several cemeteries on Long Island with the possible existence of a cemetery on Deer Island. Again, however, it noted that Deer Island had not been as intensively surveyed as Long Island. It noted that Long Island in its entirety was being considered for nomination as part of the Boston Harbor Archaeological District. The MWRA concluded that the existence of cemeteries was not as significant as the existence of archaeological sites since the cemeteries could be moved and preserved elsewhere.

Although the movement of graves raised implementation issues, those issues were the same for each island and were not considered to be impossible to overcome.

The MWRA also reviewed the potential eligibility of the Long Island Hospital, the Deer Island House of Correction, and the Deer Island pumping station for listing on the National Register of Historic Places.

Finally, the MWRA reviewed the natural resources of the two islands. While little or no adverse impacts to the natural resources on Deer Island were found, with the exception of the removal of the drumlin on Deer Island in the case of a secondary treatment plant being sited there, it was determined that the wetlands and barrier beach at Long Island might be adversely affected by the construction of either a primary or secondary treatment plant even if strict controls were imposed. Concern was expressed that even a split secondary option would impact on sensitive areas on Long Island. In sum, the MWRA concluded that the least negative impact on natural resources would be achieved by selecting Deer Island for an all-secondary or all-primary wastewater treatment plant.

3.2.8 MITIGATION MEASURES

The MWRA used the criterion of mitigation measures to focus on and clearly consider those actions which might be or ought to be taken with regard to a particular site to make that siting choice environmentally acceptable, and to assure to the greatest extent feasible that negative impacts from the siting selection would be alleviated or compensated for. The MWRA considered both environmental and non-environmental measures.

Environmental Mitigation

Environmental mitigation measures were considered to be those steps which would minimize adverse impacts from the construction and operation of the treatment plant.

Construction impact mitigation measures reviewed included barging, land modifications and buffers, scheduling and specifications for equipment to reduce noise impact, and monitoring and response mechanisms to oversee and enforce construction mitigation efforts.

Operations impact mitigation measures examined included the use of technology, design and buffers to reduce noise, odors and visual impacts on residences, institutions and/or recreators, as well as adaptation of site layouts and monitoring mechanisms to ensure proper operation and maintenance of the treatment plant and to assure responsiveness to changing conditions.

Most of the environmental mitigation measures were explored not only separately but as part of discussions involving reliability, effect on neighbors, cost, site layouts and effect on natural and cultural resources and are addressed to varying degrees under each of those topics in the FEIR. The MWRA articulated throughout these discussions a strong commitment to environmental mitigation, particularly as it would reduce negative impacts on the nearby receptors. It also recognized, however, that the extent of the mitigation employed would be

determined, in part, by balancing the cost to the ratepayers against the degree of mitigation to be achieved. In some cases a determination was made that certain amounts or kinds of mitigation would be undertaken regardless of cost. For example, it was decided that stringent odor controls would be employed no matter where the treatment plant was constructed. It was also determined that a significant degree of barging was required for the transportation of construction equipment and materials.

Most of the environmental impact measures considered were deemed applicable in some degree to all sites, but some measures were found to be required more frequently or to a greater degree under one site option or another. For example, the environmental mitigation measures to be employed when disturbing cultural or natural resources were perceived to be required more often and to entail more effort at Long Island than at Deer Island due to the greater number and value of sites located at Long Island. Balanced against this was the greater impact of noise on Deer Island neighbors and the resulting need for additional mitigative measures. The MWRA concluded that the individual environmental mitigation measures or the degree to which those measures might need to be applied differed from site option to site option but that, when all the mitigation measures for a particular site were totaled and balanced against all the mitigation measures required for another site selection, the environmental mitigation measures tended with one exception to balance out and not to be site-determinative. The exception pertained to the split plant options which would require the implementation of mitigation measures at two sites instead of one, with a substantial increase in cost. The MWRA considered this a factor to be weighed against selection of the split plant options.

The MWRA did decide that mitigation measures, while not being site-determinative between all Deer Island and all Long Island, were of critical importance with respect to whichever site it chose. Consequently, MWRA voted just prior to selecting its tentative preferred alternative site, that its FEIR for siting the Harbor Islands treatment plant should include a complete discussion of all practicable means and measures to minimize damage to the environment in connection with construction of the new sewage treatment facility including but not limited to (i) barging of construction material and personnel, (ii) limitations on unnecessary construction period traffic, (iii) controls on construction noise, (iv) controls on operating noise and odors, (v) visual enhancements of the site, (vi) alternatives to through-neighborhood trucking of chlorine for purposes of facility operations, (vii) construction of deep ocean outfalls, and (viii) development of compatible recreational uses on the site and elsewhere in Boston Harbor. The Board also voted on the day it made its tentative preferred alternative selection that it preferred that sludge management facilities be located off-site from the treatment facility.

Non-Environmental Mitigation

The MWRA considered non-environmental mitigation to be an important consideration in the siting decision and a necessary adjunct to the construction of a treatment plant of the size and complexity planned. Non-environmental mitigation measures examined were the opening of Shirley Gut, which would physically isolate Deer Island from the mainland, rehabilitating or reconstructing access bridges, development of recreational or other multi-use possibilities for the sites considered, protection against future facility overload, assurances of plant operating performance, employment of innovative technology, and relocation of the existing

institutions. With respect to the measures reviewed, the ones determined to be site-specific were those concerning access bridges, opening of Shirley Gut, and relocation of the existing institutions.

As discussed in the text regarding the criterion of effect on neighbors, the MWRA evaluated the comparative difficulty and cost regarding rehabilitation or replacement of access bridges and determined that it would be more costly to repair, replace or construct new bridges for access to Long Island.

After examination of the geologic processes and currents affecting Shirley Gut, the need for and high cost of maintenance to keep the Gut cleared, the numbers of regulatory requirements for undertaking such a project and the possibility that its being opened would result in greater nearshore pollution and perhaps permit movement of polluted waters from Boston Harbor through the gut to the eastern shores of Point Shirley and Winthrop, the MWRA determined that the opening of Shirley Gut was not a feasible mitigation measure and that other means of separating Deer Island from the mainland should be considered if a need for separation were determined necessary or desirable.

The relocation of the existing institutions was determined by the MWRA to be a critical non-environmental mitigation measure. This conclusion resulted from the MWRA's evaluation of: the effects of noise, odor and visual aspects of the treatment plant on the persons working in or inhabiting the institutions; the reduction in reliability which would result from construction of the treatment plant on sites constrained by the presence of the institutions; the far greater construction cost and ongoing maintenance and operational costs which would result from having to construct the treatment plant on a constrained site; and the greater recreational potential which would be available for the harbor if the institutions were removed. With respect to cost, recreational potential and the effects of noise, the MWRA concluded that it was even more important to relocate the House of Correction than the Long Island hospital, since the negative impact from retaining the existing institution on the same site as the treatment plant was greater for Deer Island than for Long Island. The MWRA also determined that while regional impacts would be more equitably distributed by the relocation of either institution, more equitable distribution would result from the relocation of the House of Correction due to the nature of the respective institutions and the number and kinds of regional impacts already experienced by the Town of Winthrop. The MWRA further noted that property values were more likely to be increased in the Town of Winthrop by the removal of the House of Correction than those in the City of Quincy by the removal of the hospital, and that the health and safety of residents of the Town of Winthrop were apt to benefit by the relocation of the House of Correction.

In sum, the MWRA concluded that if either Long Island or Deer Island were selected, the existing institutions should be relocated. As between the two islands, the MWRA decided that it was more important and more beneficial to remove the House of Correction if Deer Island were selected than it was to relocate the hospital if Long Island were selected. Some decision makers felt that if Deer Island were selected, the House of Correction must be relocated. For these decision makers, the relocation of the House of Correction was not a mitigation matter but an action compelled by the other criteria.

In evaluating the removal of the institutions, the MWRA placed strong emphasis on the implementability of such a measure. It received and considered commitments made by those authorities empowered to and responsible for any such relocation and determined that the implementability of relocating Deer Island House of Correction was extremely likely -- far more likely than relocating the hospital.

As with environmental mitigation, the MWRA indicated its strong commitment to non-environmental mitigation by voting for the preparation of a complete discussion, for use by the Board of Directors, of proposed non-environmental mitigation measures for the construction of the Harbor Islands treatment plant including, but not limited to, construction workforce hiring preferences for residents of impacted communities, protection against diminished real estate values from nearby construction activities, preferential economic considerations for impacted communities, and funding for repair of bridges, roads or other physical infrastructure damaged by construction activities.

3.2.9 CRITERIA WEIGHING PROCESS

The MWRA concluded that while all the criteria were important, some criteria were of relative equivalent value when applied to the various site options and were not site-determinative. Those criteria were: reliability, effects on neighbors, and implementability, as well as the environmental mitigation part of mitigation measures.

The five criteria which the MWRA concluded were site-determinative were: cost, equitable distribution of regional impacts, harbor enhancement, effect on natural and cultural resources, and non-environmental mitigation. All the site-determinative criteria except equitable distribution of regional impacts weighed in favor of selecting Deer Island as the site for the wastewater treatment plant. While the considerations of fairness implicit in the equitable distribution of regional impacts were valued very highly by the MWRA, they were not sufficient, by themselves, to outweigh the considerations of cost, harbor enhancement, effect on natural and cultural resources, and non-environmental mitigation measures.

In addition to determining which island should be the site for the construction of the Harbor Islands wastewater treatment plant, the MWRA concluded that whichever island was chosen, any existing institutions on that island should be removed. It based that conclusion on the results of applying the criteria of reliability, cost, harbor enhancement, effects on neighbors, and mitigation measures. Furthermore, the MWRA found on the basis of cost, equitable distribution of regional impacts, effects on neighbors (health and safety)*, harbor enhancement, implementability, and mitigation measures (non-environmental) that Deer Island without the House of Correction was the best site configuration considered. For some decision-makers, these latter criteria compelled the conclusion that if Deer Island were to be chosen as the site for the treatment plant, the House of Correction had to be removed.

* While health and safety issues originating from the construction and operation of a wastewater treatment plant were found not to be site-determinative, health and safety were considered to be enhanced by the removal of the House of Correction.

3.2.10 TENTATIVE SELECTION

On July 9, 1985, on the day prior to its selection of a preferred alternative site, the MWRA voted its determination that the cost of a new wastewater treatment facility would be enhanced if the facility could be constructed on a site unrestricted by another existing institution, and that the removal of any existing conflicting institution would effectively serve to mitigate the impact of the location of a new wastewater treatment facility on surrounding communities.

In addition, the MWRA voted to direct its staff to work with any and all elected or appointed officials for the purpose of expediting the removal and relocation of any other institution located on whichever island it ultimately designated as the preferred alternative site for the new wastewater treatment facility. It further instructed its interim Executive Director to take certain actions to implement its position.

On July 10, 1985, the Board of Directors of the Massachusetts Water Resources Authority, in two separate votes, each ten to one, designated Deer Island as its preferred alternative for the siting of a new primary treatment wastewater treatment facility and as its preferred alternative for the siting of a new secondary treatment wastewater facility for Boston Harbor. The designations were explicitly undertaken for the purpose of completing final environmental and other precommencement review and to serve as the basis for undertaking only such additional work in the nature of planning, design, site assembly and any other work as can be accomplished prior to the availability of the Final Environmental Impact Report.

3.2.11 FINAL SELECTION

The following is the text of G.L.C. 30 Section 61, Findings by the MWRA on the Selection of Deer Island as the Site for Wastewater Treatment Facilities in Boston Harbor.

> On February 3, 1986, the MWRA made its final selection of a site for the proposed harbor island wastewater treatment plant. The selection of Deer Island as the location for the new facility brought to a close eight years of evaluation, discussion, comment and refinement of siting issues. Most of the history of the process followed and information explored is contained in the Supplemental Draft Environmental Impact Statement/Draft Environmental Impact Report (SDEIS/DEIR) and the MWRA's Final Environmental Impact Report on the Siting of Wastewater Treatment Facilities in Boston Harbor (FEIR).
>
> In particular, the latter document details the decision process engaged in by the MWRA from its inception in early 1985 through to its tentative selection of Deer Island as the site for the wastewater treatment facilities in July, 1985. Since July, the MWRA has continued to gather information which it has published in the FEIR, has received and evaluated comments to the FEIR including the Secretary's Certificate of Adequacy, and has reviewed EPA's Final Environmental Impact Statement and comments submitted on that document. Based on this information and on its previous examinations and evaluation, the MWRA has made its final selection. The following sets forth the findings upon which that final site selection rests and the process by which it was completed.

DECISION PROCESS

In addition to its prior deliberations leading to the tentative selection of Deer Island as a site for the harbor island treatment plant, the MWRA evaluated two new categories of information in making its final siting selection. The first, technical information collected or refined between the July 1985, decision and the publication of the FEIR, was presented to and discussed by the MWRA Board of Directors at a series of public board meetings held throughout the fall of 1985. During these meetings, the MWRA reviewed and approved the content of the FEIR and adopted commitments to major mitigation measures contained in that document.

The second category of information reviewed by the MWRA was public and official comment to the FEIR, including the Certificate of Adequacy issued by the Secretary of the Executive Office of Environmental Affairs. In addition, the MWRA staff reviewed the Environmental Impact Statement issued by the Environmental Protection Agency and the Board of Directors reviewed the comments to that document as well as a summary of relevant distinctions between the FEIS and FEIR.

The information thus gathered was then evaluated for its applicability to the method of decision-making to be used in the final selection, for the effect of the information on the application of decision criteria to site options and for its effect on the mitigation measures to be adopted by the MWRA. A summary of that evaluation follows.

DECISION-MAKING METHOD

Selection of Criteria

The MWRA chose to maintain the eight criteria utilized in its tentative site selection process: Reliability, implementability, harbor enhancement, impacts on cultural and natural resources, costs, effects on neighbors, mitigation and equitable distribution of regional responsibilities. These criteria had been selected originally by the MWRA in response to the decision process carried out through the SDEIS/DEIR and the comments on that process. The Secretary of Environmental Affairs ("Secretary"), in his Certificate of Adequacy on the FEIR ("Certificate") approved the use of Equitable Distribution of Regional Responsibility as a means of assessing the more emotional, unquantifiable aspects of siting but opined that mitigation was better addressed only after a siting selection and not as a part of the siting decision process. As to the latter, the MWRA found that the use of mitigation as a criterion in arriving at a site selection had served a useful purpose and had contributed a focus different from the discussion of mitigation after a site was selected and that it was better to continue the decision process as already begun rather than making a major shift in the use of criteria at the culminating point in the decision process.

Weighing of Criteria

The Secretary's Certificate on the FEIR had recommended that each criterion be assigned a relative importance in the final decision. The MWRA reviewed the eight criteria selected and determined that they should be given equal weight as compared to each other.

Site Options

The MWRA, in reviewing the information gathered in light of the criteria utilized, found that a number of earlier determinations made in its tentative decision process should remain intact. Some of these determinations, once confirmed, served to eliminate certain site alternatives from consideration. For example, the MWRA confirmed its earlier tentative site decision that Nut Island was unacceptable for the construction of a treatment plant of the size contemplated, particularly with the filling of Quincy Bay which would be required. The Secretary's Certificate had acknowledged and found this conclusion to be acceptable, and other comments had only served to support this position.

The MWRA also confirmed its tentative decision that the four split plant options be rejected on the grounds that only the criteria of reliability and equitable distribution of regional impacts favored the selection of any of the split plant options, while the concerns encompassed in the remaining criteria were adversely affected by those alternatives. For example, the split island options would be more costly to construct, operate and maintain; would cause aggravated impacts to a wider universe of neighbors -- thus causing the need for greater mitigation; would be more difficult to implement because of the need to obtain approximately twice as many permits; and did not significantly lessen the impact of single island alternatives on cultural or natural resources or harbor enhancement. There was no additional or different information presented to persuade the MWRA to change this position.

As a result of these findings concerning site alternatives, the MWRA was left with a comparison of all Long Island and all Deer Island as possible sites for the harbor facility. A summary of the analysis of these two site alternatives in light of each of the criteria used and the information gathered as it affected those criteria, and the conclusions reached, follows.

APPLICATION OF DECISION CRITERIA TO THE ALL LONG ISLAND AND ALL DEER ISLAND SITE ALTERNATIVES

CRITERIA WITH NO SITE DETERMINATIVE EFFECT

In examining Long Island and Deer Island in light of the eight criteria, the MWRA found two criteria, reliability and effects on neighbors, to be of relatively equivalent value and therefore not to be site determinative.

Reliability

The MWRA had previously found reliability to be non-site determinative in its tentative decision because the size and configuration of each of the islands presented the same potential for use of design and layout to provide for reliability of the waste treatment system. The MWRA, in its current evaluation on reliability, noted that no new information had been presented to change that determination and confirmed its earlier decision.

Effects on Neighbors

The MWRA also found the effects on neighbors to be roughly equivalent between the two islands. As before, effects on neighbors were reviewed in six components: traffic impacts, noise impacts; odor impacts; visual impacts; property value impacts and safety impacts.

Traffic

Following its initial determination that the traffic impacts were comparable between the two sites, the MWRA commissioned a study to augment information provided in the SDEIS/DEIR traffic analysis. This analysis examined roadway conditions, assembled traffic counts, determined the present level of service on the roadways (LOS), and evaluated the impact of expected construction traffic. The MWRA concluded that for the predicted level of construction related traffic there was sufficient roadway capacity leading to each site during peak hours and that the impact although somewhat worse at some intersections for access to Long Island, was relatively comparable.

The MWRA also further explored the feasibility of barging, identifying the types of barging and/or water transportation that might be needed and sites that could be utilized. The MWRA made commitments to a level of barging, to caps on construction-related traffic and to busing of workers, all of which is set out in the Commitments to Mitigation section below.

The MWRA reviewed traffic-related comments received on the FEIR. The MWRA concluded, based on its original evaluation and the additional traffic information and comments collected since its tentative decision and its strong commitment to mitigation measures, that the traffic impacts remained roughly equal and did not favor either island.

Noise

The MWRA, in its tentative decision, adopted the then current position of EPA that noise levels at Deer Island would result in greater impact to neighbors, particularly the close neighbors at the House of Correction. However, that position was predicated on EPA's view that Long Island as a site for the treatment plant could not contain the Long Island hospital whereas the Deer Island site could encompass the House of Correction.

The MWRA in its final selection compared the sites equally, i.e. both sites with existing

institutions and both sites without those institutions. The MWRA concluded that when the sites without institutions were compared, there was more noise impact on neighbors at Deer Island than at Long Island. If the sites were compared with the institutions present, then the severity of impact on the residents or workers at each institution was equivalent.

To explore whether noise levels at Deer Island could be kept at acceptable levels, the MWRA retained an acoustical consultant to evaluate expected noise levels during both construction and plant operation for the Deer Island site. The consultant also furnished information to the Board on existing acoustical conditions, applicable regulations and an evaluation of the expected effectiveness of noise mitigation measures.

The MWRA concluded that for the nearest residence the noise levels from both construction and operation were within applicable legal standards. Furthermore, during the daytime the projected noise would be indistinguishable as compared to the existing ambient levels. At night, with a minimum of construction to be anticipated, nighttime noise would not be an impact. During plant operation, if power was generated on-site, a slight increase in background levels over existing levels was determined to be likely.

Based on this information and upon review and assessment of comments on noise, the MWRA concluded that while noise impacts upon receptors other than the current institutions would be greater at Deer Island, those impacts could be maintained at acceptable levels. The MWRA also found that the noise impacts at Deer Island prison or Long Island Hospital, because of the proximity of those institutions, would raise the noise levels above the legal standard and would require extraordinary mitigation measures to be adopted.

Odor

Odor studies conducted on behalf of the EPA have indicated that potential odor impacts on neighbors are comparable, regardless of plant location. This confirmed the MWRA's tentative decision that the issue of odor was not site determinative. The MWRA further recognized that odor control was a paramount concern and that stringent odor controls would be utilized no matter where the treatment plant was located. As a result of further work presented since its tentative selection, the MWRA concluded that control stystems such as wet scrubbers and carbon absorption columns would likely be effective in controlling the odors. The MWRA confirmed its tentative decision that odor impacts were not site determinative and committed itself to a limit of no detectable odor off-site as well as a goal of no objectionable odor on-site.

Property Values

Reviewing trends in real estate values and the impacts of other noxious facilities on property values, the MWRA confirmed its tentative decision that the effect on property values, to the extent that that effect could be predicted, was not site-determinative.

Visual Impacts

In its tentative decision the MWRA determined that a treatment plant on either island have a negative impact on persons in the existing institutions due to proximity. With respect to residential neighbors, it was determined that if the institutions remained, there would be a somewhat greater negative impact from a treatment plant on Deer Island. If the House of Correction were removed, however, modifying land forms and landscaping could be used to screen the treatment plant from most residences.

Health and Safety

Health and safety concerns of the community -- such as traffic impacts on schools and the elderly, chlorine delivery, air quality reduction from traffic or the facility operation -- were examined and found once again not to be site-determinative factors.

Summary of the Effects on Neighbors

Most of the effects considered within each of the subcategories of effects on neighbors were found to be roughly equivalent between Long Island and Deer Island. For those two categories in which a somewhat more negative impact was discerned for Deer Island, noise and visual impact, the degree of difference in impact was not sufficient to change the balance of effects on neighbors between the two sites.

SITE DETERMINATIVE CRITERIA

The MWRA found the remaining six criteria to have a site-determinative effect. Five of the criteria favored the selection of Deer Island while one criterion, equitable distribution of regional responsibilities, favored the selection of Long Island. A summary of that analysis follows.

Equitable Distribution of Regional Responsibility

Just as in its tentative decision, the MWRA found in its final site selection that this criterion favored the selection of Long Island over Deer Island. The impacts of other regional uses such as Logan Airport, Deer Island House of Correction and the current Deer Island treatment plant were found to have greater impact on Deer Island neighbors than the airport and other regional facilities had on Long Island neighbors. The MWRA concluded that it was more unfair to site the harbor facility at Deer Island.

Cost

The MWRA again found this criterion to favor selection of Deer Island. There was no change to the cost information upon which the MWRA had made its tentative decision. Those figures still showed the construction of a treatment plant on Deer Island to be less costly than a facility at Long Island. While noting that EPA had found this criterion to

be non-site determinative and that the Town of Winthrop had concurred with this conclusion, the MWRA recognized that this reflected a value judgment by the EPA and Winthrop of the relative unimportance of the dollar difference which both EPA and MWRA agreed existed rather than different information as to the cost figures themselves. The MWRA, as the operator of the system felt that the difference in cost between the two sites was of site significant importance.

Implementability

In its tentative decision, the MWRA found implementability to be non-site determinative. The information which the MWRA had reviewed at that time covered the permitting and land acquisition issues and, based on the assessment that the numbers and types and timing considerations of permits and approvals were generally the same, had concluded that the criterion was relatively equivalent between the sites. The MWRA also noted at that time that the removal of the House of Correction from Deer Island was far more implementable than the removal of the hospital from Long Island due to the expressed support for the former by those in a position to effect the removal.

Two factors have been added to the implementability discussion since the tentative decision, however, which have caused the MWRA to change its conclusion about this criterion. The first is the concurrence in the approval by the Secretary of the selection of Deer Island as the site for the treatment plant. The second is the selection of Deer Island by the EPA as its preferred alternative. The choice of Deer Island as the preferred site by both a state regulator and a federal regulator, each of which has responsibilities in further permitting or approvals concerning the construction and operation of the treatment plant and related facilities, increased the likelihood of successful and expeditious processing of the many regulatory reviews and permits pertaining to the Deer Island site. It also suggests a facilitating of the disposition of federal land located on Deer Island. In light of these factors, the MWRA has found in its final siting decision that implementability is no longer non-site determinative and that it weighs in favor of selecting Deer Island.

Harbor Enhancement

A further exploration into recreational potential of Deer Island conducted during the tentative decision process was completed for the FEIR and confirmed what had already been suggested during the tentative decision process: that a greater potential existed for Deer Island than had been suggested in the SDEIS/DEIR. However, the possibility of this greater potential had been discussed when the MWRA made its tentative selection and its confirmation did not change the MWRA's determination that harbor/enhancement favored siting the treatment plant at Deer Island. The MWRA still found that Long Island's recreational resources included natural and undeveloped aspects which could not be recreated if lost; that Long Island as a park could be brought to reality sooner since it did not have sited on it both a prison and a current treatment plant which had to continue operating until the new plant was on line; that there were indications that official support and dollars had already been or could readily be mobilized to make a park on Long

Island a reality; and, finally, that the adverse visual impact on the harbor was greater from a treatment plant on Long Island because of the Island's position in the harbor and its configuration.

Effect on Natural and Cultural Resources

In examining the natural and cultural resources of each island, the MWRA took into consideration additional pieces of information received since its tentative decision. In particular, the MWRA considered the results of a study, which it had commissioned, of parts of Deer Island which had never been adequately evaluated before for the existence of archaeological or historical resources. That study confirmed the existence of a cementery in the northeastern part of the island and also confirmed the potential eligibility of the Deer Island pump station and portions of the Deer Island House of Correction complex for nomination to the National Register. Subsequently, the Massachusetts Historical Commission found that the pump station, and two buildings in the prison complex met National Register criteria. In its comments on the FEIS, the Commission also noted that Long Island in its entirety had been nominated to the National Register as a component of the Boston Harbor Islands Archaeological District, that the Long Island hospital complex also met National Register criteria of eligibility and that historic burial grounds existed on Long Island.

All the information received concerning these resources was a confirmation of material already considered to be potentially true during the MWRA's tentative decision. The MWRA found, as it had in its tentative selection, that Long Island possessed more resources and more unique resources than Deer Island and that these resources, particularly the unique resources, would be adversely impacted by the siting of the harbor treatment plant facility on Long Island.

The MWRA noted that EPA had found this criterion to be non-site determinative but recognized that EPA had hypothesized layouts which could avoid these resources without fully exploring the technical feasibility of those layouts. The MWRA had assured that the layouts upon which their conclusions rested were technically feasible.

Mitigation

The MWRA utilized the criterion of mitigation to focus on and clearly consider those actions which might be or ought to be taken with regard to a particular site to make it more acceptable. The utilization of this criterion in the siting decision process brought to the fore and highlighted mitigation measures which might be site specific and permitted the MWRA to weigh the need for those measures in its siting selection. Early analysis of mitigation needs during the decision process also laid the groundwork for a thorough understanding and appreciation of mitigation measures to be adopted once a site was chosen. The mitigation measures to which the MWRA finally committed itself in the implementation of its site selection of Deer Island are contained in the Commitments to Mitigation section which follows.

With respect to the effect of the mitigation criterion in the siting selection process, the MWRA confirmed its earlier finding that mitigation favored the selection of Deer Island.

While various measures to mitigate construction and operation impacts such as noise and odor or the destruction of natural or cultural resources might shift the balance slightly toward one site or the other within each of those categories, the total number of kinds and degree of mitigation required for one site or the other tended, with one exception, to balance out roughly equal as a whole. The one exception was the mitigation measure of relocating the existing institutions. The MWRA found in its tentative decision and confirmed in its final decision that it was critical to relocate whichever existing institution was located on the chosen site due to the adverse environmental effects which accrued from constructing the treatment plant on a constrained site in close proximity to the particular institution. However, the MWRA also found that there was more net benefit to building the treatment plant on Deer Island and removing the House of Correction than building on Long Island and removing the Long Island Hispital since removal of the House of Correction would favorably affect property values and the safety of the curreunding community and would promote equitable distribution of regional facilities. Further details as to the findings of the MWRA regarding the removal of the existing institutions and the Deer Island House of Correction in particular is contained in the Commitments to Mitigation section which follows.

Final Siting Decision

Having found two criteria effectively neutral between Long Island and Deer Island (Reliability and Effects on Neighbors), one criterion favoring the selection of Long Island (Equitable Distribution of Regional Responsibility) and five criteria favoring selection of Deer Island (Cost, Implementability, Harbor Enhancement, Effects on Natural and Cultural Resources and Mitigation), and having given each criterion equal weight, the MWRA determined that the most appropriate site for the harbor island wastewater treatment facility is Deer Island.

COMMITMENTS TO MITIGATION

Recongizing the need to adopt all feasible measures to mitigate the adverse environmental impacts, the MWRA, as part of the FEIR, set forth a series of mitigation commitments designed to alleviate the impacts associated with the construction and operation of the Harbor Islands plant. During the process of making its final siting decision the MWRA reviewed the public comments on the proposed mitigation commitments and the comments received from the Secretary of Environmental Affairs and adopted a final series of mitigation commitments. This section sets out those commitments.

--Commitments on Flow and Growth
--Commitments on Plant Maintenance
--Commitments on Odor Control

--Commitments on Noise
--Commitments on Barging
--Commitments on the Use of Liquid Chlorine
--Commitments on the Relocation of the Deer Island House of Correction

Commitments on Flow and Growth

Recognizing the need for responsible management and being sensitive to the possible need for expansion of the proposed Harbor Islands treatment plant, the MWRA has made the following commitments with respect to flow and growth:

- The MWRA will undertake all necessary and prudent planning and management initiatives to avoid overloading the Harbor Islands treatment plant.

- The MWRA will not expand the treatment plant capacity unless or until it has implemented flow management techniques and has developed and implemented a program to avoid excess pollutant loading. These techniques and programs include:

    - Conducting infiltration/inflow reduction programs

    - Instituting water conservation programs that can reduce wastewater flows

    - Pricing of water and sewer services to promote the conservation of water, thus reducing wastewater flows

    - Controlling pollutant loads through pricing strategies and pretreatment programs

    - Controlling both flow and loads through regulatory controls, such as flow reduction programs to compensate for new connections

    - The MWRA will develop monitoring and triggering programs so that it will be able to test the effectiveness of the flow management techniques and to provide the MWRA with the ability to determine when planning for the MWRA's next increment of treatment capacity should be undertaken

- If the MWRA determines, through its monitoring and triggering programs, that the flows and loading are increasing at rates higher than projected in the FEIR, it will take all necessary steps to plan, design, and construct ancillary facilities including (but not limited to):

    - Flow control structures, such as on-line and off-line storage to minimize peak flows at the plant

    - Septage treatment facilities to reduce pollutant loadings on the Harbor Islands plant

- o If the ancillary facilities are insufficient to accommodate increased flow and loading and to prevent exceeding the design capacity of the Harbor Islands treatment plant, the MWRA will take all necessary steps to plan, design, and construct satellite treatment plants unless it determines it would be economically or environmentally infeasible to do so.

- o Notwithstanding the foregoing, the MWRA does not intend the adoption of the above commitments to require the postponement or cancellation of any capital program contained in the Authority's Fiscal Year 1986-88 capital budget that services to eliminate an existing problem of sewage backups.

The purpose of these commitments is to confirm the MWRA's desire to establish a sound and rational program for assessing future capacity needs, to respond to public concerns on overloading and future system expansion, and to provide a framework within which additional capacity will be planned.

Commitments to Operation and Maintenance

MWRA has already made clear its commitment to improved operations and maintenance by approving both a substantially increased operating budget and by authorizing significant increases in operations and maintenance staff for existing facilities. MWRA's commitment to maintenance is underscored by their adoption of the following assurances:

- o Review of Recurrent Budgets. Annual operating budgets will be carefully scrutinized to be certain that these budgets reflect not only a sound maintenance program for existing facilities but that the budgets reflect any new facilities expected to be in service during the budget year. The MWRA will link budget expenditures with performance indicators that reflect the efficiency and effectiveness of the maintenance programs.

- o Renewal/Replacement Expenditures. More than $100 million in construction projects have been initiated at the Nut Island and Deer Island treatment plants to replace much of the antiquated equipment at these plants. These upgraded programs are expected to be completed in 1989 and will contribute significantly to the reliability of the existing plant equipment. Capital budgets in future years will continue to reflect the important role that R/R plays in the maintenance of treatment facilities. The MWRA's maintenance procedures will be modified at an early date to incorporate record keeping procedures that will provide a rational basis for R/R investment in future years.

- o Review of Maintenance Procedures. Prior to the completion of the on-going upgrade program, the MWRA will initiate a review of its existing maintenance procedures. Strengthened maintenance procedures will be designed including an aggressive housekeeping and preventive maintenance program. These procedures will be amended as new treatment facilities are constructed.

- o Initiate Early Planning. To ensure that operations and maintenance considerations are included as an integral part of the planning for all new facilities, MWRA will require that the plant's facilities plan include a preliminary plan of operations. The preliminary plan of operations will identify the additional or unique O & M requirements of the recommended facilities, including staffing and special training needs, manuals, special tools and workshops, and estimated budget considerations. This preliminary plan of operations will provide MWRA with two to four years' lead time prior to completion of facilities to incorporate the maintenance requirements of new facilities into on-going maintenance programs.

- o Adoption of Performance Indicators. MWRA will adopt performance indicators into the agency's proposed management information systems that will permit the Authority to review on a regular basis the level-of-effort and the performance of the maintenance activities. Indicators such as plant performance, equipment availability, maintenance labor/expenditures, custodial inspection reports, spare parts inventory, and equipment age will be monitored to regularly examine the efficiency of the maintenance efforts. Additionally, the Authority will involve the community in reviewing maintenance programs to provide focus on issues of local importance.

Commitments on Odor Control

The MWRA commits to the construction of the treatment pant that will control odors so as to eliminate detectable odors off-site and to control odors as necessary to protect the public health. Furthermore, the MWRA commits to the control of odors so as to minimize, to the maximum extent feasible, objectionable odors on-site.

The type of odor control needed will be selected during the facility planning effort. Sampling of the odor potential characteristics of the influent wastewater will be conducted as part of the facilities planning to provide the necessary data to develop a program of source control and to size and select the odor control equipment.

The most reliable means of measuring odor performances is the human nose. In order to measure the plant odor performance, an odor panel will be created composed of individuals from the community as well as individuals from the MWRA. The panel will routinely monitor for odors to ensure that no objectionable odors are occurring off-site. The panel will also respond to odor complaints received by the plant, by assisting in the investigation of the odor and recommending odor control techniques.

Commitments on Noise Control

The MWRA is committed to complying with all the legal standards of both City of Boston noise control ordinance and the Department of Environmental Quality Engineering.

Because of the scale of the proposed plant, however, the MWRA is setting as a goal noise abatement that goes beyond simply adhering to the City of Boston code. The MWRA has

to define, by the FEIR, what noise levels may be achievable and will examine means of noise abatement throughout the planning, design and operation of the facility.

The MWRA further commits to the development of a program for avoiding adverse noise impacts, the components of which shall be resolved during facilities planning but which shall include the following:

- The establishment of an Acoustical Review Board. The Acoustical Review Board will include representatives from the community as well as engineers and MWRA staff.

- The use of available and feasible noise control techniques, which may include items such as the evaluation of the acoustical characteristics of operational equipment and flexible scheduling of construction activities to minimize noise.

- The establishment of necessary training and hiring practices to assume the best possible control of noise impacts.

- The involvement of the community in the development of noise control programs and the participation of community representatives in those programs.

Commitment on Barging and Busing

The determination that barging and busing are necessary is a direct consequence of the volume of traffic associated with the construction of the proposed facility and the limited capacity of roadways leading to the plant site. The Traffic section of the FEIR describes the capacity of the roadways. The commitment to barging, therefore, also requires a commitment to maximum traffic levels associated with the construction of the plant. Those traffic levels are defined for both the pier construction period and for the period thereafter.

Prior to construction of the piers, it is not feasible to barge materials to the site. Therefore, the MWRA has given a high priority to the identification of barge sites, design of pier facilities and construction of those piers. The Authority is engaged in the selection of a consultant for the necessary barge and pier facilities. The MWRA commits to limiting the trucking of materials for construction of the piers to a maximum of 20 trucks per day.

Upon completion of the pier facilities, the barging of almost all heavy construction equipment and materials is, based on the analyses conducted to date, an achievable level of barging. The level of commitment is conditioned, however, to allow for contingencies that may result from scheduling or operational problems. The extent of such contingency trucking, after the completion of the piers, will be limited to a service fleet of eight trucks. Also, in order to minimize impacts associated with commuting of construction workers to the plant site, the Authority has committed to the busing of all workers, using a maximum of 28 buses per day.

In addition, the Authority will undertake an evaluation of the practicality of providing ferries to transport construction workers to the job site.

Commitments on the Trucking of Liquid Chlorine

The MWRA has committed to cease the trucking of liquid chlorine through the streets of Winthrop as soon as possible when water access facilities become operable and the transport of alternate disinfectant or barging of liquid chlorine becomes feasible.

Commitment on Relocation of the Deer Island House of Correction

The MWRA has determined that the Deer Island House of Correction must be relocated from Deer Island by those parties with jurisdiction over its operation and that such relocation must be deemed a mandatory mitigation measure.

The MWRA's conclusion with respect to this mitigation measure is based on its findings throughout the tentative and final site decision process relative to the environmental impacts resulting from the construction of the harbor island treatment plant on either island with the existing institutions present, and the benefit to be gained by the removal of the existing institution from the island selected as the site for the treatment plant. Many of those findings, as they relate to Deer Island were addressed by the Secretary in his Certificate as well as by numerous commentors to the FEIR, all of whom found the relocation of the prison to be a required mitigation measure. The MWRA's findings on benefits which would result from relocation of the prison are summarized as follows.

The MWRA found that the reliability of the treatment plant would be greatly enhanced by providing sufficient space for optional design. The converse was also found, that building on Deer Island with the treatment plant present would require a cramped design with reduced space between piping and flow controllers resulting in decreased uniformity of flow and reduced control over the treatment process. This, in turn, would increase the possibility of operational malfunctions or decrease the ability to monitor or redress such episodes, resulting in adverse impacts on neighbors of the treatment plant.

The MWRA also found that building the treatment plant in such close proximity to the prison would cause severe visual and noise impacts on the persons living and working in that institution. The noise impacts on the prison would be above the legal standard and would require extraordinary mitigation measures to be undertaken to ameliorate the effect. Mitigation measures, such as buffers or berms, would place additional area demands on an already constrained site. Other measures, such as timing and placement of construction and equipment could adversely impact the length of construction time. Removal of the prison would eliminate such impacts and the need for such mitigation measures.

Relocation of the prison would also reduce costs. The cost of constructing the treatment plant on a constrained site with the prison present, of operating and maintaining the plant under those conditions, and of providing the necessary mitigation measures to

alleviate the proximity of the treatment plant to the prison would be significantly greater than building without the prison.

Finally, additional benefits to recreators and to non-prison receptors would accrue from the removal of the prison. Those benefits would include alleviating the visual impact of the treatment plant on Winthrop receptors by providing space for screening and modifying landforms, providing space for recreational and open land use, reducing traffic on Winthrop's streets by the approximately 114 autos a day currently used at the prison, substantially alleviating the combined impact of regional facilities on the Town of Winthrop and by enhancing the safety of the community.

For all these reasons and the reasons cited by the Secretary, some of which are echoed by other commentors, the MWRA considers the removal of the Deer Island House of Correction to be essential to the expeditious construction of new treatment facilities.

Further Measures to be Examined

The commitments to mitigation listed above comport with all mitigation measures which would be required under the MEPA statute. In fact, in many instances, as noted by the Secretary in his certificate on the FEIR, the MWRA has addressed many issues to a far greater degree than was required and has made commitments in these areas accordingly.

Nevertheless, the Secretary, in his final Certificate, has made recommendations that certain measures be undertaken either sooner than might be required or with respect to current facilities as opposed to the new treatment plant which is the subject of the FEIR.

The MWRA considers these suggestions positive and worthy of serious review. It has directed staff to evaluate the Secretary's suggestions and to recommend within thirty to ninety days where, when and how they may be responded to and the nature of the recommended response. The suggestions by the Secretary include:

1. The "Sewer Bank" concept be further explored and feasible programs developed to eliminate excess flow and accommodate new connections.

2. Accommodate future growth within the service area through satellite plants.

3. Continued and strengthened programs to monitor flows to provide sound data to gauge the effects of flow management.

4. Implement odor panel and formal odor complaint response at existing facility.

5. Consider real time monitoring of odors, perhaps using hydrogen sulfide as an indicator.

6. Consider development and implementation of a monitoring program for VOCs and other air toxics in the wastewater stream and in the ambient air.

7. Recommend implementation of an acoustic Review Board to monitor and respond to noise complaints at existing facility; and supplement such a noise program now and at the new treatment plant with periodic noise monitoring.

Summary of Impacts and Findings of Limitation of Impacts

The MWRA finds that the environmental impacts resulting from the construction of the Boston Harbor wastewater treatment facility are those impacts as described in the Draft Environmental Impact Report, elaborated on and refined in the Final Environmental Impact Report and commented upon in these G.L.C. 30, Section 61 Findings.

The MWRA further finds that its selection of Deer Island as the site for the wastewater treatment facility, and its commitment to the mitigation measure set out in the Commitments to Mitigation section of these G.L.C. 30, Section 61 Findings constitute all feasible measures to avoid or minimize the environmental impacts described.

Record of Decision

The text of EPA Region I's Record of Decision on the Final Environmental Impact Statement Siting of Wastewater Treatment Facilities for Boston Harbor is as follows:

> The U.S. Enviromental Protection Agency (EPA) has prepared this document as its Record of Decision (ROD) for the Final Environmental Impact Statement (FEIS) on the siting of the Massachusetts Water Resources Authority (MWRA) wastewater treatment faciities which will abate the pollution of Boston Harbor.
>
> The MWRA has the responsibility of selecting the site for the wastewater treatment facilities. EPA's primary responsibilities are to conduct an evaluation of environmental acceptability under the National Environmental Policy Act (NEPA), provide federal financial assistance if available, and ensure rapid compliance with the Clean Water Act.
>
> EPA issued a Supplemental Draft EIS (SDEIS) in December, 1984 and a FEIS on December 2, 1985 on the siting of wastewater treatment facilities for Boston Harbor. These documents evaluated the environmental impacts of various site options for facilities to treat Greater Boston's wastewater in compliance with water pollution control laws. The SDEIS also served as a Draft Environmental Impact Report (DEIR) under the provisions of the Massachusetts Environmental Policy Act (MEPA) for the Metropolitan District Commission (MDC). Since publication of this joint document, the sewer functions of the MDC have been reorganized into the MWRA. The Board of Directors of the MWRA chose to follow an independent but parallel decision process and to publish a separate but concurrent Final Environmental Impact Report (FEIR) under state law.

Following the concurrent publication of EPA's FEIS and MWRA's FEIR, EPA and MWRA conducted joint public hearings before reaching their respective final decisions. Public hearings were held on January 13, 14 and 15, 1986 in Quincy, Boston and Winthrop. Oral and written comments were submitted during the comment period. The public comment period ended on January 21, 1986 for the FEIS and January 24, 1986 for the FEIR.

In February, 1986, the MWRA determined that "the most appropriate site for the harbor island wastewater treatment facility is Deer Island." This ROD identifies EPA's final decision on the siting issue. This ROD is being circulated to inform the public of this decision and to respond to the comments on the FEIS.

I. EPA's FINAL DECISION ON THE SITING OF SECONDARY WASTEWATER TREATMENT FACILITIES FOR BOSTON HARBOR

With the understanding that EPA will require the MWRA to carry out the program of specified mitigation measures identified on pages 52-55 of the FEIS, Volume I, EPA's decision is that its preferred alternative is the All Secondary Deer Island alternative, which is set forth in the EIS and described below. All Secondary Long (without the hospital) is also environmentally acceptable and is preferred over Split Secondary Deer-Long (without the hospital). The only alternative which EPA finds unacceptable is Split Secondary Deer-Nut. The decision process and the program of required mitigation measures is described in more detail in Section III.

EPA's preferred alternative for secondary treatment, All Secondary Deer, would expand the existing primary wastewater treatment facility at Deer Island to a secondary treatment plant. It would reduce the existing primary treatment facilities at Nut Island to a small headworks. It would include construction of a major new pipeline or tunnel from Nut Island to Deer Island and of an effluent outfall to the east of Deer Island Light. The existing wastewater treatment facility on Deer Island would be increased from 26 acres to about 115-140 acres while on Nut Island the existing wastewater facility would be reduced from 12 acres to about 2 acres.

This alternative would commit almost all the land on Deer Island south of the existing prison to wastewater treatment and level the most prominent topographic features of the island. This alternative would also require the construction of a bulk materials loading pier(s) and roll-on roll-off facilities at the site, and associated terminal(s) on-shore.

The estimated construction cost of this alternative would be about $1.135 billion and its annual cost of operation, maintenance and replacement would be about $50 million. Costs, acreage requirements, exact plant layout and mitigation measures will be developed in greater detail during further facilities planning on the project.

The Benefits of Moving the Prison

The MWRA favors a variation of the All Secondary Deer Island alternative which assumes that the prison would be removed as a mitigation action, and that its site would be made available for the treatment plant. This variation would also use most of the Island but prison removal would reduce the impacts of the treatment plant in several ways:

1. It would remove the receptor population (the prison workers and inmates most affected by the plant's impacts, including noise and odor).

2. It would eliminate prison-related traffic, thus offsetting construction-related and operations traffic for the treatment plant.

3. It would improve the appearance of Deer Island by removing the prison buildings.

4. It would permit opportunities for sculpting the landscape to a more natural appearance and for screening the facility from both the harbor and Point Shirley and Cottage Hill in Winthrop.

5. It would increase the opportunity for buffering noise at Point Shirley by earthen barriers on prison property.

6. It would permit the retention of a portion of the Island's shoreline for buffering and recreation.

7. It would remove prison-related anxieties from Winthrop.

8. It would make more land available for the wastewater treatment facility, possibly making construction and maintenance easier.

This variation does not eliminate the need for any of the mitigating actions proposed for the All Secondary Deer Island alternative with the prison to remain, except for those intended to reduce impacts at the prison itself, e.g., a noise barrier.

However, the process required to release the Deer Island prison site for treatment plant use could be so lengthy as to delay or frustrate the construction of this variation of the All Secondary Deer Island alternative. EPA has long advocated removal of the prison if Deer Island is to be the treatment plant site, but EPA will not require removal of the prison as a grant condition. Implementation of secondary treatment is required by the Clean Water Act and cannot be made dependent upon removal of the prison if the site is acceptable.

This ROD concludes that in EPA's judgement the All Secondary Deer Island Alternative is its preferred alternative and can be implemented without unacceptable environmental

impacts even if the prison remains.*

II. SELECTION OF ALTERNATIVES FOR EVALUATION

Federal regulations require EPA, during environmental review, rigorously to explore all reasonable alternatives for the siting of wastewater treatment facilities for Boston Harbor. Most of the alternatives initially investigated were derived from the EPA's 1978 Draft Environmental Impact Statement (DEIS), which examined only secondary treatment options, and the MDC's 1982 Nut Island Site Options Study. The Site Options Study identified eleven alternatives (eight secondary and three primary treatment alternatives), including some previously examined in the DEIS. In September, 1983, EPA and the Commonwealth conducted two public scoping meetings to receive comments on these initial alternatives from the public and from federal, state and local officials. Upon completion of the joint scoping meetings, EPA selected eleven additional alternatives for analysis, for a total of twenty-two alternatives to be studied. These included twenty alternatives for treatment at Deer, Long, Nut, or man-made islands and two alternatives including sub-regional "satellite" plants. A complete discussion of the twenty-two initial primary and secondary alternatives appears in the SDEIS at Vol II, Section 12.12. Table I is a complete list of the twenty-two initial options.

[See Table I on page 3-38 in this Section.]

III. DECISION PROCESS

To examine such a large number of alternatives, a screening process was developed jointly with the Commonwealth. Its objective was to narrow the number of alternatives being investigated and to eliminate those that clearly offered few benefits or had significant adverse impacts. This initial screening of alternatives is summarized here; it is described in detail the SDEIS. Each alternative's economic, social and environmental impacts were studied. In addition, their technical, legal, institutional and political problems were also analyzed. Specific criteria were developed for comparison and screening of the options.

---

* The Clean Water Act requires that wastewater treatment plants be constructed which will provide "secondary" treatment unless EPA, under strict statutory guidance, grants a waiver, under Section 301(h) of the Clean Water Act, permitting a lesser "primary" degree of treatment with a deep ocean dicharge. EPA has twice denied the MDC/MWRA request for such a waiver but final rights of appeal have not expired. EPA believes it is highly unlikely any such appeal, even if pursued, would prevail on the merits, or that the discharge of primary effluent into Massachusetts Bay would ultimately be permitted over the opposition of the Governor and other officials. However, in the interest of completing the NEPA review, EPA has decided in this ROD to resolve the siting of a primary treatment plant as well. The decision is the All Primary Deer Island alternative.

TABLE I

LIST OF TWENTY-TWO INITIAL OPTIONS STUDIED IN THE SDEIS

Secondary Treatment Alternatives

1a.1 Secondary Treatment at Deer Island, Headworks at Nut Island with separate North and South System Secondary Treatment Processes.

1a.2 Secondary Treatment at Deer Island, Headworks at Nut Island with combined North and South System Secondary Treatment Processes.

1b.1 Secondary Treatment at Deer Island, Primary Treatment at Nut Island for South system, separate North and South System Secondary Treatment Processes.

1b.2 Secondary Treatment at Deer Island, Primary Treatment at Nut Island for South System, combined North and South System Secondary Treatment Processes.

1c Secondary Treatment at Deer Island for North System, Secondary Treatment at Nut Island for South System.

2a.1 Secondary Treatment at Deer Island for North System, Secondary Treatment at Long Island for South System, Headworks at Nut Island.

2a.2 Secondary Treatment at Deer Island for North System, Secondary Treatment at Long Island for South System, Primary Treatment at Nut Island.

2b.1 Headworks at Deer Island for North System, Headworks at Nut Island for South System, Consolidated Secondary Treatment at Long Island.

2b.2 Primary Treatment at Deer Island for North System, Primary at Nut Island, Consolidated Secondary Treatment at Long Island.

2b.3 Headworks at Nut Island, Primary Treatment at Deer Island for North System, Consolidated Secondary Treatment at Long Island.

3a Headworks at Deer and Nut Islands, Consolidated Secondary Treatment at Lovell's Island.

3b Headworks at Deer and Nut Islands, Consolidated Secondary Treatment at a new man-made island.

Primary Treatment Alternatives

4a.1 Primary Treatment of All System at Deer Island, Headworks at Nut Island. Local Outfalls.

4a.2 Primary Treatment of All System at Deer Island, Headworks at Nut Island, Deep Ocean Outfalls.

4b.1 Primary Treatment at Deer Island for North System, Primary Treatment at Nut Island for South System, Local Outfalls.

4b.2 Primary Treatment at Deer Island for North System, Primary Treatment at Nut Island for South System, Deep Ocean Outfalls.

5a.1 Primary Treatment at Deer Island for North System, Primary Treatment at Long Island for South System, Headworks at Nut Island. Local Outfalls.

5a.2 Primary Treatment at Deer Island for North System, Primary Treatment at Long Island for South System, Headworks at Nut Island. Deep-Ocean Outfalls.

5b.1 Headworks at Deer and Nut Islands, Consolidated Primary Treatment at Long Island. Local Outfalls.

5b.2 Headworks at Deer and Nut Islands, Consolidated Primary Treatment at Long Island. Deep-Ocean Outfalls.

Satellite options 1&2 - Satellite facilities for South System with discharge to Charles and Neponset Rivers. Satellite facilities for South System with wetlands discharge.

In screening the initial alternatives, it became clear that no alternative was without some potentially adverse impacts. Furthermore, no alternative satisfied all of the criteria used in the analysis. Considering the size and complexity of the project, virtually all alternatives were considered to have at least one or more drawbacks that limited their acceptability to some affected group(s).

The initial screening process concluded that of the twenty-two alternatives studied, four secondary treatment options and four primary options conformed to these criteria and warranted further investigation and more detailed study. These alternatives reflected different approaches to the siting requirements of the MDC system. The impacts of these options also varied in their respective advantages and disadvantages. The eight alternatives are identified below according to their abbreviated names used in the EIS. (Parenthetical references in Table I refer to the nomenclature used in the initial screening process.)

a. <u>Secondary Treatment (Harbor Entrance Outfall) Alternatives:</u>

1. All Secondary Deer Island (1a.2)
2. Split Secondary Deer Island and Nut Island (1b.2)
3. All Secondary Long Island (2b.1)
4. Split Secondary Deer Island and Long Island (2b.3)

b. <u>Primary Treatment (Nine Mile Outfall) Alternatives:</u>

1. All Primary Deer Island (4a.2)

2. Split Primary Deer Island and Nut Island (4b.2)

3. All Primary Long Island (5b.2)*

4. Split Primary Deer Island and Long Island (5a.2)

A detailed assessment of the impacts of these alternatives was provided in the SDEIS. Figure I shows the eight alternatives with their respective facilities and harbor locations.

During the further preparation of the SDEIS, relevant Massachusetts agencies and the EPA agreed that it was necessary to refine the decision process because of the complexity of the siting decision and the great number and variety of factors which must be taken into account by decision-makers. The first step was to re-analyze the various arguments and considerations that had been brought to bear on this controversial siting decision by all concerned parties in order to determine their disparate objectives. These objectives were used to develop a more precise set of decision criteria against which the remaining alternatives were to be evaluated. It was the goal of the SDEIS to make the list short, yet inclusive of all concerns that had been raised. Six decision criteria were identified. Each alternative was to be evaluated to determine the extent to which it:

1. is consistent with and, if possible, promotes the fulfillment of the promise of Boston Harbor. (Harbor Vision)

2. can be implemented in a timely and predictable manner. (Implementability)

3. minimizes the adverse impacts of the facility on neighbors, taking into consideration existing conditions, facility siting impacts and mitigation measures. (Effects on Neighbors)

4. minimizes the impacts of the facilities on natural and cultural resources. (Impact on Cultural and Natural Resources)

5. can be built and operated at a reasonable cost. (Cost)

6. maximizes the reliability of the entire treatment system. (Reliability)

---

* Though the SDEIS/EIR suggested that one alternative, All Primary Long, should also be screened out and not receive further active consideration, the SDEIS/EIR and the FEIS contained a full evaluation of All Primary Long. EPA considers that all eight alternatives received an equal level of analysis.

Finally, EPA and the Commonwealth developed a comprehensive program of mandatory measures applicable to all alternatives: barging of materials, busing of workers, and noise and odor control.

Thus, in the SDEIS/EIR, EPA and the Commonwealth had narrowed the options remaining for secondary or primary treatment from twenty-two to eight alternatives, but had not arrived at a statement of two preferred alternatives, one for secondary treatment and one for primary treatment. The most important factor leading to this outcome was a desire on the part of both EPA and the Commonwealth to encourage public scrutiny and obtain formal public comment on the results of initial screening process, the large amount of new data, the new decision criteria and the proposed mandatory mitigation before proceeding to suggest two preferred alternatives.

After the close of the SDEIS/EIR public comment period, in light of the high degree of public acceptance, EPA decided to retain criteria as a way to impose order on a mass of detail in this especially complex review, and to focus on those impacts which are relevant to the choice of a site. EPA also reviewed all the public comments submitted to identify both those criteria-relevant issues which needed futher analysis prior to selection of a preferred alternative and those other issues which related to the overall project or were otherwise not criteria-relevant, but which were appropriate for inclusion in the FEIS or the FEIR. EPA performed additional analyses on potentially site-relevent topics.

EPA and the MWRA agreed that it was appropriate for each to pursue an independent decision-making process under their respective statuatory mandates but to do so in parallel and with a high degree of coordination. Accordingly, to ensure that both agencies shared a common data base, as either agency identified data needs or developed information, it was shared with the other by exchange of technical memoranda and through technical presentations at meetings with EPA's Technical Advisory Group or with the MWRA's Board of Directors or staff.

EPA systematically reviewed its entire data base using the decision criteria and evaluated each piece of data in terms of one or more of the appropriate decision criteria. EPA felt that each decision criterion was legitimate and was confident that sufficient objective data existed to permit a reasoned judgement as to the acceptability of the alternative sites.

Mandatory Mitigation Measures

Upon the completion of the review of each decision criterion, the assumed level of mandatory mitigation as set forth in the SDEIS/EIR was either confirmed or, if appropriate, modified as the result of further technical information. EPA found that the most critical need for mitigation was to reduce impact on neighbors. EPA applied a set of specific mandatory mitigation measures to all alternative sites except as noted below. The mandatory mitigation measures can be summarized as follows:

- o Barging of bulk materials to and from the site to reduce the amount of trucking through affected communities during construction;

- o Use of a roll-on/roll-off barge loading facility at the site and at an onshore transfer station to accommodate heavy trucking;

- o Busing and ferrying of construction workers to reduce commuter traffic in affected communities during the construction period;

- o Use of "maximum feasible degree" of odor control and investigation of state-of-the-art odor control technology;

- o A ban on the use of liquid chlorine at Deer Island unless there is "clear and convincing" need for it and proof that it can be handled without unnecessary risk to neighbors, including the prison workers and inmates;

- o Implementation of noise control measures during construction, including the excavation of the Deer Island drumlin from the south side so that the remaining mass of the drumlin acts as a shield, and construction of a sound barrier at the Deer Island prison.

- o Prohibition against trucking liquid chlorine to Deer Island as soon as piers and staging areas are available to commence over-water transport;

- o Exploration of alternatives to the use of liquid chlorine at the treatment plant and at the associated headworks;

- o Sampling of volatile organic compounds downwind from the existing primary plants at Deer and Nut Islands, exploration of technologies to control these compounds and installation of appropriate controls if necessry;

- o Exploration of alternative treatment processes that might be less space demanding, less costly, or more reliable than secondary treatment based on the activated sludge process;

- o Exploration of the feasibility of developing recreational uses of the site along with the treatment plant;

- o Control of dust, erosion and sedimentation.

For a detailed statement of the mandatory mitigation measures, see pages 52-55 of the FEIS Volume I. Each of these mitigating efforts will be the subject of detailed study by the MWRA as further facilities planning explores these ways of achieving acceptable levels of impact. EPA, after appropriate environmental review, is prepared to modify these mitigation measures if equally effective protection can be achieved by other methods.

In the judgement of EPA, these stringent mandatory mitigation measures include all practicable means which are necessary and appropriate to avoid or minimize environmental harm from the alternative selected. EPA acknowledges that in some cases its mitigation package differs from the mitigation commitments described in the MWRA's FEIR and its findings under Section 61 of MEPA. EPA is confident, however, that its mandatory mitigation measures would result in an extraordinary degree of mitigation which would effectively minimize environmental harm.

Final Analysis*

During the final analysis, it became clear that three of the decision criteria, through theoretically important, no longer played site-distinguishing roles.

1. On "Cost," a more detailed analysis revealed that the costs of the four alternatives were so close that EPA decided to regard this decision criterion as having neutral effect.

2. On "Reliability," each of the sites permitted treatment plants of equal reliability.

3. On "Impact on Cultural and Natural Resources," though this decision criterion included federally protected resources (wetlands, barrier beaches, recognized historical and archeological sites, etc.), the impact of plants on either Deer or Long Island would be essentially equal and acceptable. On Nut Island, however, the Split Secondary Deer-Nut Alternative would involve the serious impacts of filling of tidal areas (unless homes were taken) and this was taken into account in the final decision.

Thus, "Effects on Neighbors," "Harbor Vision," and "Implementability" remained as the principal decision criteria for EPA. EPA felt each of these three criteria represented protection of important public values of substantial weight and each will be discussed below:

1. With respect to the "Effects on Neighbors" decision criterion, should the "no prison" variation of the All Secondary Deer Island alternative be implemented, EPA concluded that a treatment plant at either Deer Island or Long Island would have acceptable and essentially equal impacts on its neighbors, with the mandatory mitigation measures in place. However, if the prison were to remain on Deer Island, EPA concluded

---

* In the following discussion it is important to note that, in the SDEIS/EIR, EPA and the Commonwealth concluded that under both Long Island alternatives, the Long Island hospital must be relocated off-island in order to avoid unacceptable impacts to "Effects on Neighbors," "Harbor Vision," and "Cultural and Natural Resources." EPA believes this conclusion remains valid.

that a plant site on Deer Island would have a greater effect on its neighbors than a site on Long Island, but these impacts as mitigated were acceptable. EPA felt that removal of the prison was desirable but not mandatory. EPA also concluded that the mandatory mitigation reduced the impacts so substantially that the plant could be constructed without unacceptable impact despite the presence of the airport and the prison.

The Split Secondary Deer-Long alternative would involve major construction activity of approximately the same perceived effect on the neighbors of each island as if the entire plant were being constructed there. Though those effects were found to be acceptable, it was felt to be unwise to impact two sets of neighbors unless there would be some benefit to another decision criterion; there was not.

Split Secondary Deer-Nut imposed severe burdens on its immediate neighbors on Hough's Neck without any corresponding benefit to Deer Island and Point Shirely. It was found to be environmentally unacceptable.

2. Considering only the "Harbor Vision" decision criterion, EPA concluded that though all four alternatives were acceptable, the All Secondary Deer alternative was preferred under "Harbor Vision". EPA believes that Deer Island's size, topography and setting give it acceptable long-term potential for rehabilitation as a park resource. However, because of Long Island's current potential as a major island park, EPA did conclude that while both All Secondary Deer and All Secondary Long satisfied the Harbor Vision decision criteria, All Secondary Deer satisfied it better.

Less acceptable were the other two alternatives. Though Split Secondary Deer-Long preserved significant potential recreation space at each island, EPA agreed with the Commonwealth that an entire island as park was preferable. Split Secondary Deer-Nut committed Nut Island to wastewater treatment without any corresponding benefit at Deer Island; though Nut Island has not been a major part of a harbor park plan, it could provide locally important open space.

3. Considering only the "Implementability" decision criterion, the following issues were of principal importance: permits and licenses, and the attitudes of the City of Boston and agencies and legislature of the Commonwealth. Even prior to the July 10, 1985, vote of the MWRA selecting All Secondary Deer Island as its tentative preferred alternative, EPA had concluded that the "Implementability" decision criterion pointed to All Secondary Deer with or without the prison because the principal remaining alternative, All Secondary Long (without the hospital), faced significant opposition. However, EPA was concerned that Deer Island prison removal was uncertain.

The July 10, 1985, and February, 1986 votes, and the MEPA Sec. 61 Findings of the MWRA, the proposing agency, which has the statutory authority to build the treatment plant and which controls much of Deer Island, confirmed EPA's conclusion that the All Secondary Deer alternative was clearly more implementable than any of the other alternatives.

The Governor's continued support of the MWRA, his renewed commitment to facilitate

relocation of the prison, and his new offer to identify a new prison site by May, 1986, further supports this result. Other officials have reiterated their support for prison removal if Deer Island is to be the site. As stated by the Secretary of Environmental Affairs in his Certificate on the FEIR, Janury 21, 1986:

> "...[T]hrough the joint struggle of all branches of government, the courts, the press, and the public, important milestones have now been passed - the creation of the Authority and <u>public consensus on siting</u>. A momentum has now built up, which I consider so powerful that the cleanup cannot and will not be stopped. The joint will of Mayor Flynn, Governor Dukakis, the General Court and our citizens is so strong that <u>I am convinced the difficulties of prison relocation can be overcome</u>..." (emphasis added)

EPA agrees with the MWRA that the reinforced support of relevant public officials for Deer Island prison removal and the continued opposition to Long Island Hospital removal makes prison removal "far more feasible" than hospital removal.

Furthermore, even if the prison were to remain, EPA notes the continued strong opposition of the city and state officials who control the future of Long Island to any use of Long Island as a treatment plant and notes their reiterated support for a Long Island park and for a continued role for the Long Island Hospital and Homeless Shelter.

Therefore, EPA confirms its previous judgement that All Secondary Deer Island (even if the prison were to remain) is more implementable than either of the other two environmentally acceptable alternatives: All Secondary Long and Split Secondary Deer-Long (both without the hospital).

<u>In summary, with mandatory mitigation</u>,

1. EPA found Split Deer-Nut to be environmentally <u>un</u>acceptable because of its severe impact on its "Neighbors" at Nut Island and on "Natural Resources," and strong barriers to "Implementability."

2. EPA found Split Deer-Long (without the hospital) to be environmentally acceptable; but EPA also found it to be undesirable because it spreads impacts on "Neighbors" and "Harbor Vision" to two islands without any benefit deemed valuable to a decision criterion. It also was unlikely to be "Implemented."

3. EPA found both All Secondary Long (without the hospital) and All Secondary Deer to have an acceptable impact on "Neighbors" and "Harbor Vision."
    a. <u>"Neighbors."</u> With mitigation, the impact of a Deer Island plant on its "Neighbors" is either equal to (without the prison) or worse than (with the prison) a Long Island plant.

b. "Harbor Vision." The impact of a Deer Island plant on the public benefits from and uses of Boston Harbor causes somewhat less harm than a Long Island plant.

c. "Implementability." Between these two acceptable and closely balanced alternatives, building a treatment plant on Deer Island (with or without the prison) is clearly more "Implementable" than building a Long Island Plant.

EPA's decision based on the foregoing analysis is that its preferred alternative is All Secondary Deer with mandatory mitigation. The FEIS contains more information on the decision process.

IV. IMPLEMENTATION, MONITORING, ENFORCEMENT OF MITIGATION MEASURES

Applicable regulations require EPA, in this ROD, to adopt and summarize an implementation, monitoring and enforcement program for its mitigation measures.

EPA's first implementation, monitoring and enforcement mechanism will be through the construction grants program. Section 201(g) of the Clean Water Act authorizes the Administrator to grant financial assistance to municipalities for the construction of municipal wastewater treatment plants. Section 511(c) of the Act states that the award of a construction grant may be considered a major federal action significantly affecting the quality of the human environment, subject to the requirements of NEPA. These statutes give EPA the authority to enforce the mandatory measures through the federal construction grants program. The mandatory mitigation measures for the selected site at Deer Island will be made necessary conditions of any Federal construction grants awarded to the MWRA during the Step 3 Construction Phase of this project.

EPA has determined, pursuant to Section IV B 7 of the 1984 Construction Grants Delegation Agreement and 40 CFR Section 3015(c), that an overriding federal interest exists in this project, in particular in regard to the implementation of the mandatory mitigation program specified in the FEIS. In order to ensure that all mandatory mitigation measures are implemented through the construction grants program, the agency will play a direct role in oversight of facilities planning, design and construction of the wastewater treatment plant including piers, outfalls and pipelines/tunnels. The specific role that EPA plans to play will be at least as follows:

- o review all sections of all the facilities plans to ensure compliance with the mandatory mitigation program as set forth in FEIS Volume I, p.53-55.

- o coordinate with the Massachusetts Department of Environmental Quality Engineering (DEQE), Division of Water Pollution Control in reviewing the plan of study for the facilities plans.

- o participate in any technical and citizen advisory committees as part of the public participation program for the facilities plan.

- o participate in the review of the draft products of the facilities plans, particularly the development of the mandatory mitigation measures.

- o EPA will review at least the specifics of the proposed odor control program, noise control program and possible volatile organic compound emissions control program to ensure that MWRA is achieving effective impact reductions required by this ROD. On the issue of liquid chlorine use, EPA will ensure in its review of the facilities plan that MWRA has undertaken a thorough disinfectant alternatives analysis. On the issue of busing, ferrying and barging, EPA will monitor the development of the facilities planning investigations to ensure that MWRA establishes the required programs to mitigate transportation impacts.

- o coordinate with DEQE for joint review and approval of the final facilities plans. The facilities plans will be approved only upon successful development of the mitigation program as outlined in the FEIS.

- o EPA will request the Army Corps of Engineers, during construction, to make periodic onsite reviews to ensure that the project is being managed properly, is on schedule, and is being constructed in accordance with approved construction drawings and specifications including mitigation measures and change orders.

In order to facilitate a high degree of review oversight by EPA, the agency intends to enter into an agreement with the DEQE Division of Water Pollution Control and MWRA to outline further details of EPA's oversight.

In addition to EPA oversight and participation in further facilities planning, EPA intends to assume primary responsibility for NEPA review by the preparation of any environmental assessments or supplemental EIS's determined to be necessary in connection with these activities. EPA and the Army Corps of Engineers plan to enter into a Memorandum of Understanding in order to minimize delays in any environmental reviews involving both agencies.

Second, the MWRA is under federal court order to initiate facilities plans for the shore-side piers and staging areas, on-site piers and staging areas, outfalls and tunnels or piplines. The MEPA unit of the Executive Office of Environmental Affairs has made the determination that EIR's will be prepared on these facilities plans. In addition, the facilities plans will include EID's which provide environmental evaluations of the final facilities plan components. EPA will conduct an independent environmental review, under NEPA, of these facilities plans, except for those aspects of the wastewater treatment plant covered by this EIS.

Third, in the unlikely event that federal funding for this project were to be totally unavailable due to the termination of the Construction Grants Program, this project will require other federal actions which bring it within NEPA. These include the transfer of surplus federal lands by the General Services Administration (GSA); permit actions by the Corps of Engineers for the construction of piers and the disposal of dredged material or fill; and possible permit actions by EPA for the ocean disposal of fill. Each of these actions triggers independent opportunities to implement and enforce the mitigation program. For example, GSA intends to dispose of the surplus property in accordance with the FEIS and has committed to incorporate the mandatory mitigation measures into its own Record of Decision as appropriate.

Fourth, this project is now the subject of a federal court action (United States of America v. Metropolitan District Commission, et al., Civil Action No. 85-0489 D.C. MA and a related case.) In the event of the cessation of the construction grants program, EPA will also consider seeking an order of the federal court mandating that the mitigation program laid out in the FEIS be implemented.

Fifth, it should also be noted that the MWRA has committed to the Commonwealth that it will undertake a set of mitigation measures which are, with the exception of prison removal, substantively equivalent to those required by EPA. These are contained in the Section 61 Findings of the MWRA to the Secretary of Environmental Affairs under the MEPA.

[See also Section 3.2.11 (FINAL SELECTION) of this Volume.]

FURTHER ENVIRONMENTAL REVIEW UNDER NEPA

EPA expects that further environmental review under NEPA relating to the cleanup of Boston Harbor will include appropriate study of the following phases of the process, including cumulative impacts:

1. Long-term residuals management, including the processing, transport and ultimate disposal of sludge. Scoping for this EIS has already commenced.

2. The construction of pier(s) and staging area(s) at the treatment plant site and on shore to allow for barging of bulk construction materials, equipment, and work crews during construction, and possible transport of sludge. In the event that an existing pier cannot be located on the mainland, an additional pier or piers and staging area(s) would need to be constructed there.

3. The construction of an under-harbor tunnel or pipeline to transport wastewater to the treatment plant.

4. The water quality and construction impacts of an outfall pipe or pipes through which effluent will be discharged.

5. The possible disposal of earthen or dredge materials which might need to be removed from the site of the secondary treatment plant prior to construction.

6. The possible transport, handling, storage, and use of chlorine at the secondary treatment plant, depending upon the outcome of studies by MWRA regarding the environmental acceptability of its transport, handling, storage and use.

7. Combined sewer overflow projects.

CONCLUSION

EPA has engaged in a decision process which gathers technical information, exposed it to extensive public scrutiny, developed very stringent mitigation measures, and evaluated the alternatives in terms of disclosed decision criteria. EPA believes this open process has arrived at a fair and reasonable conclusion that the upgraded treatment plant, considered singly or in combination with other conditions, will be constructed and operated with acceptable environmental results.

3.3 RELATED PROJECTS

3.3.1 PROJECTS

Although the Secondary Treatment Facilities Plan is the beginning of the key project in the Boston Harbor Cleanup Program, there is a long list of projects that are being planned, designed or are under construction to upgrade and expand the MWRA's wastewater collection and treatment capabilities. These projects are grouped into the following programs:

Treatment Plant Upgrade
  Nut Island Immediate Upgrade
  Deer Island Fast Track Improvementss
Interim Residuals Management
  Interim Sludge Processing and Disposal
  Interim Scum Management
Long-Term Residuals Management
Water Transportation Facilities
Combined Sewer Overflows
Harbor Research and Monitoring

In addition to the above wastewater programs, several waterworks projects have either a direct or an indirect bearing on the secondary treatment facilities planning. MWRA has also initiated several projects to strengthen its ability to direct and manage its extensive capital program and its extensive day-to-day operational responsibilities. The projects designed to strengthen

MWRA's institutional capability are described in Volume VII, Institutional Considerations. The related wastewater programs are described briefly in the following paragraphs.

3.3.2 INDUSTRIAL WASTE PROGRAM

In February of 1973, MWRA's Industrial Waste Program began to acquire data on all industries within the 43 cities and towns which comprise the sewerage district. This program has become the means whereby the Authority enforces Federal, State and MWRA regulations which govern the discharge of wastewater to the sewer system. The goals of the enforcement strategy are to decrease and control pollution loads to the treatment works; increase safety for maintenance and operational personnel; reduce illegal waste discharges such as extraneous water and septage from non-member municipalities; and prosecute for willful damage or vandalism.

The Industrial Waste Program, which was approved by the EPA in July of 1982, is being implemented in four phases: Inspections, Monitoring, Permitting and Enforcement.

Inspection Activities

The inspection program includes on-site inspection of all indusries in the district. It requires a discussion period with appropriate plant personnel to ascertain the type of activity being performed at the facility, the raw materials used, products and services produced, and the particular processes and unit operations employed. A tour of the facility is also conducted to verify the information received. Industries suspected of discharging a questionable waste are required to submit the results of laboratory analyses, performed on representative samples of the process waste by an independent laboratory, for review and evaluation by the Authority. The results of analyses, along with other pertinent information (permit application, inspection reports) on the industry, are used to determine whether or not the wastes are in compliance with the MWRA's Rules and Regulations. A permit application must be completed by all users discharging industrial wastes.

An intensified Industrial Inspection Program has commenced as a result of the increase in staff and resources. In Fiscal Year 1987, approximately 425 industrial inspections were conducted.

Septage Disposal Inspection Program

The Septage Disposal Inspection Program is basically divided into two activities: first is the oversight of the septage control activities of the member municipalities with septage receiving locations; and second is surveillance of each septage receiving location to determine compliance with MWRA Rules and Regulations and to identify any illegal septage dumping.

Each member municipality which operates or has designated a septage receiving station is responsible for the control and monitoring of all activities at the septage receiving location. The Water Quality Section evaluates control procedures at each septage receiving location for the purpose of determining the municipality's ability to control the dumping of septage from

non-member communities, to prevent the discharge of industrial or toxic wastes, and to verify the origin of all septage received at each septage receiving location.

In some instances the possibility of illegal or uncontrolled dumping at certain septage receiving locations is suspected. In response to these instances, surveillance of the septage receiving site is conducted in order to document septage disposal, and possibly identify illegal dumping activities requiring enforcement of dumping restrictions.

Identification of I/I and Surcharging During Routine Investigations

In addition to identifying sources of toxic discharges to the sanitary sewer system, investigations at industrial facilities often identify the illegal discharge of "clean" water, also known as inflow. During these industrial investigations the most common form of inflow uncovered is non-contact, uncontaminated cooling water and non-contact, uncontaminated industrial process water.

In addition to identifying these and other sources of inflow, inspection personnel often identify excessive use of water and make recommendations to limit water use. These recommendations serve to reduce the flow in the already overloaded sewer system, which helps to minimize surcharging.

Monitoring Activities

The Monitoring Section of the Water Quality Department continually participates in a variety of activities, the most significant being monitoring for the Industrial Waste Pretreatment Program. More specialized areas of monitoring include sampling at the Treatment Plants, fulfilling NPDES Permit monitoring requirements, soil sampling, beach sampling, and verification of discharges and connections. Monitoring activities during Fiscal Year 1987 numbered 565, compared to 200 in Fiscal Year 1986.

Collection of industrial waste samples from industries discharging into the Authority's Sewer System yields a profile of industrial wastes currently entering the system and provides the basis for enforcement to eliminate unacceptable concentrations of toxic and potentially harmful substances. The samples collected are forwarded to a laboratory for analysis, where strict Quality Assurance/Quality Control procedures are employed. Analytical results from this monitoring, in conjunction with information derived from inspecting and permitting activities, assist in determining the acceptability of the discharge and whether enforcement action is warranted.

The Monitoring Team has been involved in site assessment and the implementation of the monitoring program to fulfill the NPDES Permit requirements. The permit requires monitoring at Deer and Nut Island Treatment Plants and at three Combined Sewer Overflow (CSO) facilities (Cottage Farm Chlorination and Detention Station, Charles River Estuary CSO Treatment Facility, Somerville Marginal CSO Pretreatment Facility). At the treatment plants, samples are taken monthly for parameters not monitored daily by the plants, such as organics, metals and cyanide.

Beach sampling has been frequently requested in response to reports of odor problems and unidentified growths or discharges into the harbor.

Other monitoring activities include sampling soil or sludge to determine the degree of contamination to assist in proper disposal decisions, verification of discharges and connections via dye tests and researching sewer line maps, groundwater sampling, and sampling at construction or cleanup sites before discharge to the sanitary sewer system.

Municipal Permits/Sewer Use Discharge Permits

Sewer Use Discharge Permits are issued to each sewer user discharging industrial wastes located in the Authority Sewer District regardless of size, type or volume of discharge. For permitting purposes, the Sewerage Division has classified users into four categories according to the nature of their wastes. The categories are as follows:

1. Industries requiring pretreatment.
2. Industries having some toxic discharges but at concentrations which do not require pretreatment.
3. Industres which have non-toxic discharge in addition to sanitary flow.
4. Dry industries or industries with sanitary flow only.

Sewer Use Discharge Permits are revised as new information is received. At present, much of the activity involving permits is due to revisions and renewals, which are done on a daily basis.

Compliance and Enforcement

The Authority has been extremely successful in working with its Sewer Users in a cooperative spirit to eliminate existing or potential discharge problems, since the inception of the Industrial Waste Program. Over the years, thousands of industries and other sewer users have been inspected, monitored and issued permits. Through the inspection, monitoring and permit phases of the Water Quality Department's Industrial Waste Program, many of these industries were found to be in violation of acceptable discharge practices. Any continued violations of permit conditions or Sewer Use Rules and Regulations will result in enforcement actions to assure compliance with acceptable discharge practices. New Sewer Use Rules and Regulations promulgated May 1, 1987 have broadened the scope of MWRA enforcement powers, including rights to:

1. Issue an order to cease and desist any such discharge violations;

2. Direct a User to submit a detailed schedule, subject to such modifications as the Authority deems necessary, setting forth actions to be taken to correct or prevent a violation;

3. Issue an implementation schedule ordering specific actions and a time schedule;

4. Revoke, modify or deny a permit issued to the User by the Authority;

5. Impose administrative penalties up to $10,000 per day of continued violation, and seek payment for damages to its system pursuant to 360 CMR 10.105 and 360 CMR 2.00;

6. Bring a civil or criminal action as provided by law;/ or

7. Take any other action available to it under federal, state or local law or regulation.

In cases where significant resistance is given to the Authority's discharge regulations, enforcement actions have been initiated. Enforcement actions to date range from informal meetings with the offending companies to legal actions taken through the Office of the Attorney General of the Commonwealth of Massachusetts. The results have been civil penalties ranging upward of $600,000 and agreements for judgements mandating adherence to strict compliance schedules.

The Authority's newly promulgated Administrative Penalty Regulations and Rules for Adjudicatory Proceedings will enable the Water Quality Department to be more effective in enforcement. The Authority is also establishing firmer policy and procedures which will be followed for the imposition of Civil Penalties in those future cases which require the assessment of fines.

3.3.3 TREATMENT PLANT UPGRADE PROGRAMS

Both the existing Deer Island and Nut Island Treatment Plants are being upgraded to extend the useful life of the installed facilities until the new treatment facilities can be constructed and placed into operation.

The Nut Island Immediate Upgrade Project began in January, 1983 and is expected to be completed in May, 1988. Eight projects costing approximately $12 million have been initiated to extend the useful life of the Nut Island Plant approximately ten years. Table 3.3.3-1 summarizes the eight immediate upgrade projects. Table 3.3.3-1 also describes other projects that are planned or underway to rehabilitate the existing treatment plant.

The Deer Island Treatment Plant Fast Track Improvementss Program consists of several projects to raise the operating efficiency of the existing plant to an acceptable level. The construction of these upgrading projects started in June, 1986 and is expected to be completed in March, 1990. The Deer Island Fast Track Improvements Program is summarized in Table 3.3.3-2. Other projects that are expected to improve the service life of the existing facilities on Deer Island are also described in Table 3.3.3-2. These rehabilitation projects also include upgrading the remote headworks facilities which function as an integral part of the Deer Island Treatment Facilities.

TABLE 3.3.3-1
NUT ISLAND IMMEDIATE UPGRADE

o <u>Power</u>

- Rebuilding of one engine generator
- Installation of 2000 kw transformer for purchased off-site power to the site

o <u>Preliminary Treatment</u>

- Addition of influent flow meter (sonic type) on the High Level Sewer
- Installation of new ventilation system, odor control equipment, and explosion-proof electrical components to the grit facility
- Removal of comminutors downstream from the grit chambers
- Rebuilding of the effluent channels from the grit tanks
- Replacement of air header to the preaeration basins
- Rebuilding of one preaeration blower motor

o <u>Primary Sedimentation</u>

- Structural rebuilding of tanks and repairing of leaks
- Levelling of tank floors
- Replacement of all weirs
- Replacement of sludge collection equipment

o <u>Digesters</u>

- Replacement of outside sludge piping from the primary sludge pumps to the anaerobic digesters
- Digester roof rehabilitation

o <u>Outfalls</u>

- Installation of an automated sluice gate at the outfall
- Cleaning of the two main outfalls

o <u>Electrical Distribution Substation Replacement</u>

o <u>Sewerage Pump Switchgear Replacement</u>

TABLE 3.3.3-2

DEER ISLAND TREATMENT FACILITY FAST TRACK IMPROVEMENTS

- Pump Station and Power Station Improvements

  - 5 new 90 mgd influent sewage pumps
  - 4 new 2000 Hp electric motors
  - New graphic control center to monitor sewage flow
  - New cooling water system for engines
  - New pumps for process water building
  - New heating system process water building
  - 2 new 6000 kw dual fuel, engine/generator sets
  - New switch gear/electrical distribution center
  - New fuel storage system for engines

- Rehabilitation of Digesters
  - 4 new floating roofs
  - New internal digester piping
  - New gas meters at each digester
  - New waste gas burners with meters
  - 6 new spiral heat exchangers
  - 4 new sludge hot water pumps
  - 1 new boiler
  - Rehabilitation of 2 Ingersoll-Rand gas compressors
  - A new heating and ventilating system for both the sludge thickener and the digester complexes
  - A gas detection system for both complexes

- Sludge Thickener Improvements

  - Remove existing tank mechanisms
  - Remove existing bridges, pumps and associated piping
  - Install new thickener mechanisms and bridges
  - Install new sludge transfer system, pumps and compressors
  - Install associated piping, electrical and control instrumentation

- Primary Sedimentation Basins Improvements

  - New grit collection system
  - New grit classification building
  - New scum concentration building

Table 3.3.3-2 (cont'd)

- New chemical feed building
- Influent and effluent sampling stations
- 80 new motorized influent sluice gates and 80 stainless steel baffles
- New flow splitter plate, to equalize grit distribution
- Structural repairs to the sedimentation basins and bridges
- 48 new stainless steel aeration leaders and diffusers
- 3 new air compressors for the aeration channels

o Chlorine Rehabilitation

- 8 new evaporators
- 8 new chlorinators
- 2 new scale systems
- New HVAC system
- New roof
- New piping and distribution system for chlorine and process water

o Electrical Upgrade

- 4 new electrical distribution substations
- New conduit for substations
- New motor control centers throughout Deer Island

o Dual Fuel/Generator Overhaul

- Overhaul of 5 diesel enginers 1000 Hp
- Overhaul of 4-700 kw generators

o Deer Island Remote Headworks Improvements
(Columbus Park, Chelsea Creek and Ward Street)

- New grit collection and removal equipment for all 12 channels (four at each facility)
- New climber-type mechanical screens
- New HVAC equipment
- New odor control equipment
- Improvements to electrical systems
- Monorails, hoists and bridge cranes
- Hydraulic power units for sluice gates

o Winthrop Terminal Headworks Improvements

- Three climber-type mechanically cleaned bar screens
- Grit collection equipment

Table 3.3.3-2 (cont'd)

- Three inlet sluice gate operators and hydraulic power system
- Overhaul six sewage pumps (4-16,000 gpm and 2-32,000 gpm)
- Six new drive motors and controls
- Screening discharge enclosure
- Two stair access/egress towers

3.3.4 INTERIM RESIDUALS MANAGEMENT PROGRAM

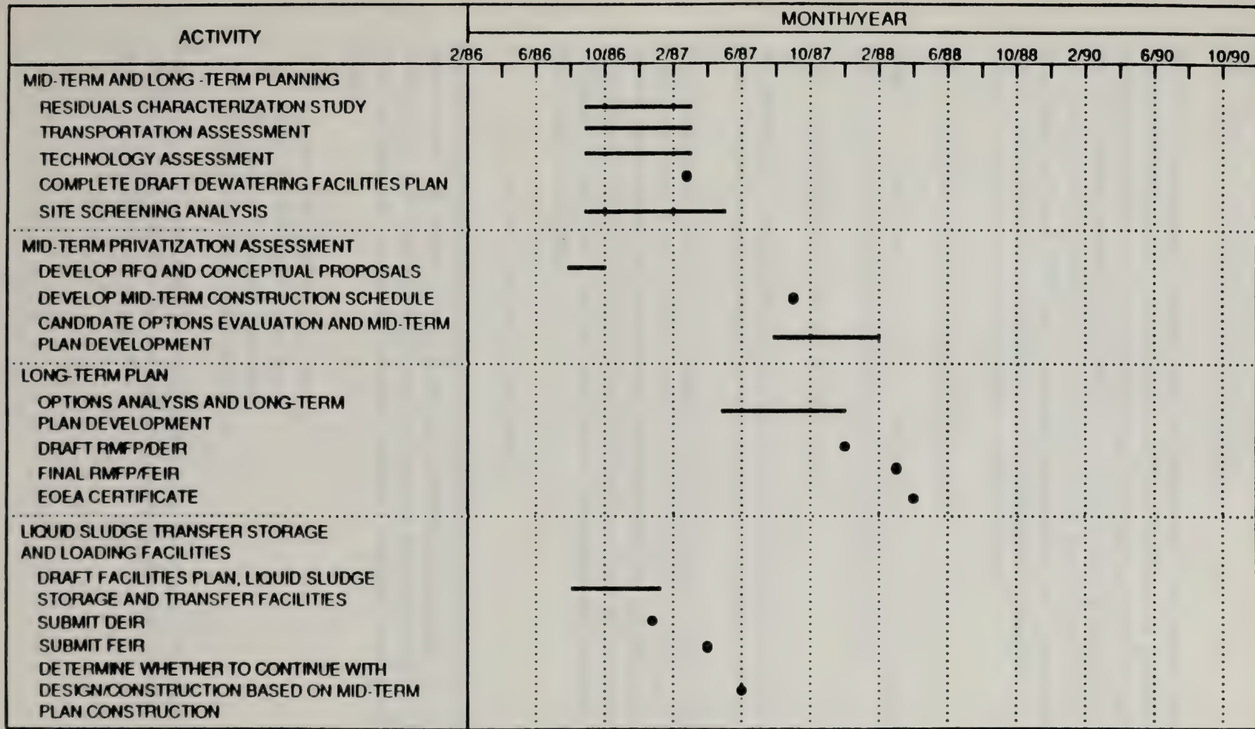
The Interim Residuals Management Program is intended to provide the facilities necessary to cease the discharge of sludge to the ocean by 1991. MWRA is presently soliciting proposals from private firms to provide land based disposal of sludge until the long term management facilities now being planned are constructed in 1995. The Interim Residuals Management Program includes sludge from both the Deer Island and the Nut Island Treatment Plants.

A second component of the Interim Residuals Management Plan is interim scum management. Scum is the floatable material that is skimmed from the surface of sedimentation facilities at both treatment plants. Scum is currently mixed with the sludge and discharged to the Harbor. Because these materials are the more obnoxious and visible discharge to the Harbor, the removal of these materials has been given the highest of priorities. For the interim period at Nut Island, scum screening, chemical conditioning and landfill disposal was selected as the recommended scum handling option. Design of these facilities was initiated in May, 1987. At Deer Island, the recommended plan for termination of scum discharges involves a one year demonstration project. This project includes chemical fixation of all Deer Island scum by a private contractor with storage on-island. Initiation of this period is anticipated in November, 1987. At the end of the one year demonstration, a decision will be made to build permanent facilities or to continue with a service contract.

A third component of the interim residuals management plan is a composting pilot plant. Composting stabilizes organic materials and destroys bacteria and viruses in sludge. Composted sludge has the potential for use as a soil supplement for production of turf grass, horticultural uses at green houses, use as a low-grade fertilizer or use as a landfill cover material. The pilot plant was initiated in 1984 and currently processes fifteen dry tons per day of sludge. The pilot plant serves the dual purpose of reducing the quantity of sludge discharged to the harbor and at the same time provides a compost product to test and develop a market for the material in the greater Boston area. The compost pilot also provides valuable information for the assessment of the viability of composting as a long-term residuals management option.

3.3.5 LONG-TERM RESIDUALS MANAGEMENT FACILITIES PLAN

The facilities planning for the long term management of residual solids is being conducted concurrently with this planning effort. The planning effort includes assessment of the quantity and quality of Deer Island and Nut Island sludge, survey of available sludge processing and transport technologies, selection of appropriate technologies, screening of potential disposal sites and selection of optimum facilities and sites. Design and construction will include both on-island and mainland facilities. The facilities planning is scheduled for completion in 1988. Figure 3.3.5-1 illustrates the general flow of planning activities for the residuals management facilities plan.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.3.5-1
RESIDUALS MANAGEMENT PROJECT SCHEDULE

3.3.6 WATER TRANSPORTATION FACILITIES

The Water Transportation Program includes the construction of the piers and related facilities to move materials, workers and equipment to and from Deer Island for the construction of the new treatment facilities and at Nut Island to support construction of the new headworks facility. Facilities planning for both on-island and on-shore piers is essentially complete. On-island piers are now being designed. Construction of these essential facilities is expected to commence in March, 1988 and be completed in September, 1989. Construction of the on-shore piers is expected to start in September, 1988 and be completed in May, 1990. See Figure 3.3.6-1 for a schedule of water transportation facilities planning.

3.3.7 COMBINED SEWER OVERFLOW PROGRAM

MWRA is currently evaluating a means of abating pollution from combined sewer overflows. Figure 3.3.7-1 denotes the overall facilities planning for the CSO program.

3.3.8 HARBOR RESEARCH AND MONITORING

The ultimate goal of this project is the design and implementation of a plan for action directed towards cleaning up Boston Harbor and protecting the Harbor in the future.

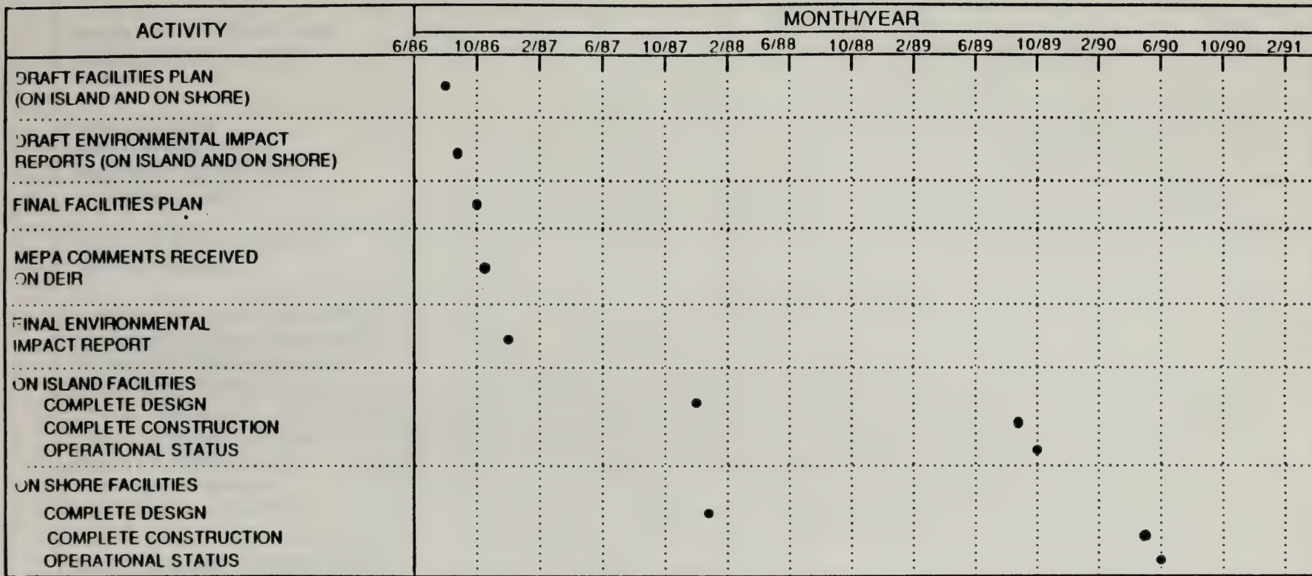
A Technical Advisory Group (TAG), established in 1986, produced a "Study Plan for Basinwide Management of the Boston Harbor/Massachusetts Bay Ecosystem". This plan defined the goals for research and monitoring in Boston Harbor and Massachusetts Bay that will be closely tied to management issues. The study plan further identified many issues facing environmental managers. Of these issues, five have been identified as high priority, requiring a well-focused scientific study.

3.3.9 WASTEWATER TRANSPORT PROGRAM

MWRA member communities discharge their wastewater through 1825 connections and 5400 miles of local sewers to 228 miles of MWRA sewers and 10 MWRA pump stations. In 1976, the EMMA study recommended approximately $1.7 billion in improvements to sewers through the year 2000. Since 1976, the sewer relief program has informally taken on a definition involving four major projects:

- Braintree-Weymouth Relief Sewer
- New Neponset Valley Relief Sewer
- Framingham Extension Relief Sewer
- Wellesley Extension Relief Sewer

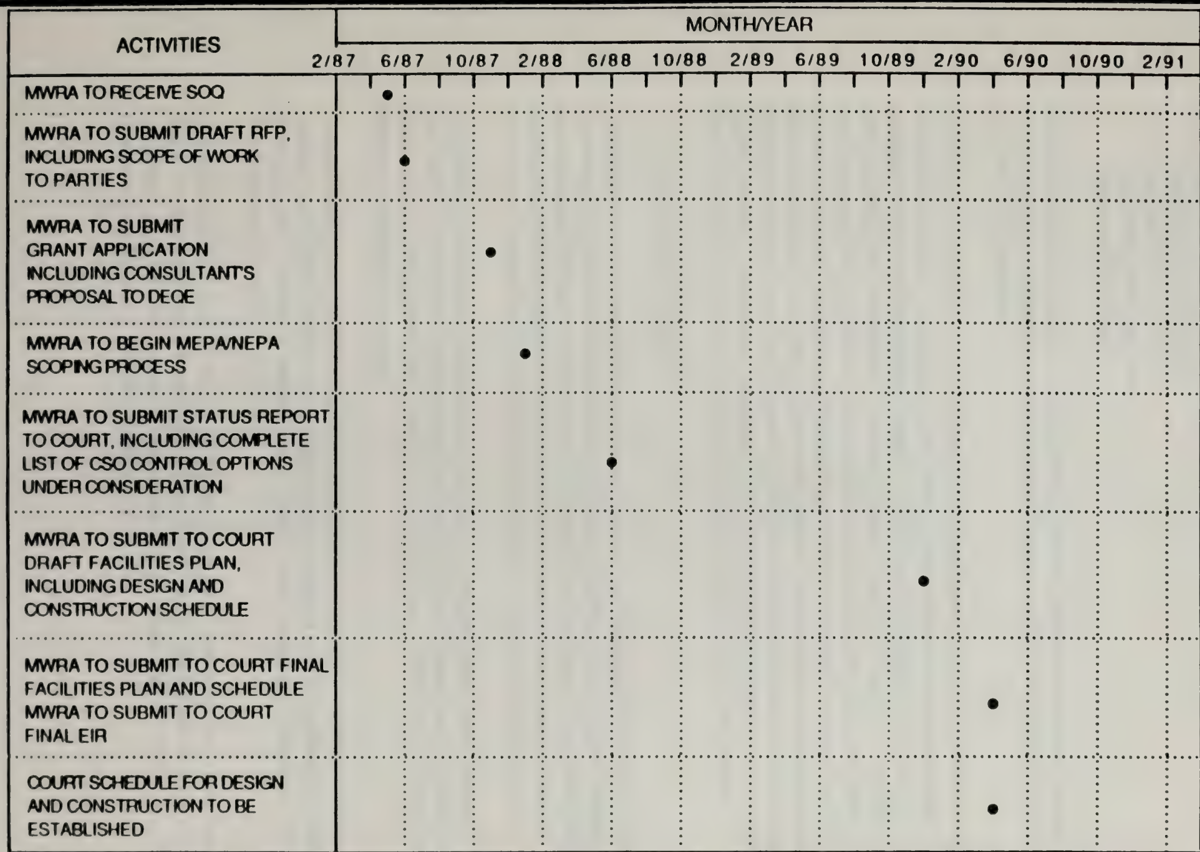
Progress has been slow on the four major projects due to the complex and controversial nature of each project. The MWRA has, however, demonstrated success with the following projects either under construction or completed:



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.3.6-1
WATER TRANSPORTATION FACILITIES PROJECT SCHEDULE

TABLE [illegible]



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.3.7-1
COMBINED SEWER OVERFLOWS
PROJECT SCHEDULE

- Millbrook Valley Relief Sewer
- Reading Pumping Station
- Reading Extension Sewer
- East Boston Pumping Station
- Hingham Force Main

The Water Transport Program is moving forward, with the potential downstream impacts of the utmost concern. The Southern System Modeling Project, which is now underway, is the first major step in this process.

MWRA plans to participate in a joint public and private effort to establish a Harbor monitoring and research program. The program will conduct research that will report on existing conditions and measure incremental change as the residuals management program and treatment plant upgrading are implemented. The priority areas to be studied include: (1) sources and fate of contaminants; (2) effects of contaminants and the health of the living resources; (3) nutrient enrichment; (4) economic, legal, political and social science assessment and; (5) public health impact. The study of these areas requires both short term projects designed to answer particular questions and a monitoring program that will determine long term impacts of human activities on the marine ecosystem. The technical results produced by these studies should be used in multiple-use management endeavors conducted by several agencies.

3.4 PROJECT MILESTONES

Though pollution of Boston Harbor has been a matter of public concern since the late 1960's, awareness was heightened in December of 1982 when the City of Quincy filed a lawsuit against the Metropolitan District Commission and the Boston Water and Sewer Commission (BWSC). Quincy sought relief from the pollution of Quincy Bay, which it claimed was resulting from the discharges of untreated and partially treated sewage from Nut Island and Moon Island.

As a result of this suit and the recommendations of the court-appointed special master, a bill was filed to remove sewer responsibilities from the MDC and to place them in a financially and organizationally independent public authority. On December 19, 1984, the Massachusetts Water Resources Authority was created.

On the following day, the EPA announced its intention to take additional action to help secure a harbor cleanup and brought suit in federal court, requesting a set of deadlines for pollution control projects. Filed at the end of January, 1985, the suit named four defendants: the MDC, the MWRA the state and the BWSC.

As a result of this lawsuit, on May 8, 1986 the United States District Court of Massachusetts imposed "major milestones" as long-term target dates to assist facilities planners toward the completion of primary and secondary treatment facilities. These dates are as follows, with milestone dates relating to this facilities plan in bold type:

Design and Construction of Piers and Staging Areas and Facilities Planning

On-Island

a. Complete Design	12/87
b. Bid Construction	5/88
c. Award Construction	8/88
d. Complete Construction	9/89
e. Attain Operational Status	6/90

On-Shore

a. Complete Design	1/88
b. Bid Construction	6/88
c. Award Construction	9/88
d. Complete Construction	5/90
e. Attain Operational Status	6/90

Facilities Planning

a. Project Start	5/86
b. File ENF (s) (see appendix F of this volume)	6/86
c. Complete Draft Facilities Plan	9/87
d. Complete Draft EIR	11/87
e. Complete Final Facilities Plan	12/87
f. Complete FEIR	2/88
g. Complete Environmental Review	4/88
h. Accept Facilities Plan	5/88

Construction of Treatment Plant, Outfall, and Inter-Island Wastewater Conveyance System

a. Initiate construction of new primary treatment facilities	**12/90**
b. Complete construction and commence operation of new primary treatment facilities	**7/95**
c. Initiate construction of outfall	**7/91**
d. Complete construction of outfall	**7/94**
e. Initiate construction of inter-island wastewater conveyance	**4/91**
f. Complete construction of inter-island wastewater conveyance	**12/94**
g. Initiate construction of secondary treatment facilities	**during 1995**
h. Complete construction of secondary treatment facilities	**during 1999**

The 1986 Court order allows for the re-examination of these long-term target dates for the completion of this Facilities Plan.

Section 3 References

G.L.C. 30 Section 61, Findings by the MWRA on the Selection of Deer Island as the Site for Wastewater Treatment Facilities in Boston Harbor.

Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control, January 1, 1987. Project Update Boston Harbor Cleanup Effort, prepared by Steven G. Lipman.

Massachusetts Water Resources Authority, November, 1985. Final Environmental Impact Report on Siting of Wastewater Treatment Facilities for Boston Harbor.

City of Quincy v. Metropolitan District Commission No. 138477, Superior Court, August, 1983, Report of the Special Master Regarding Findings of Fact and Proposed Remedies.

Technical Advisory Group For Boston Harbor and Massachusetts Bay, Massachusetts Executive Office of Environmental Affairs, July, 1986. Study Plan For Basinwide Management of The Boston Harbor/Massachusetts Bay Ecosystem.

Section 4

SECTION 4.0 BASIC PLANNING CRITERIA

4.1 PLANNING PERIOD

The planning period used in this facilities plan encompasses the period from now through the year 2020. This represents the first twenty years of operation of the secondary plant which has been stipulated by the federal court to be in operation not later than the end of 1999. The use of twenty-year planning periods is considered generally accepted practice in the engineering profession, and is required by facilities planning regulations issued by the U.S. Environmental Protection Agency (EPA).

4.2 SERVICE AREA

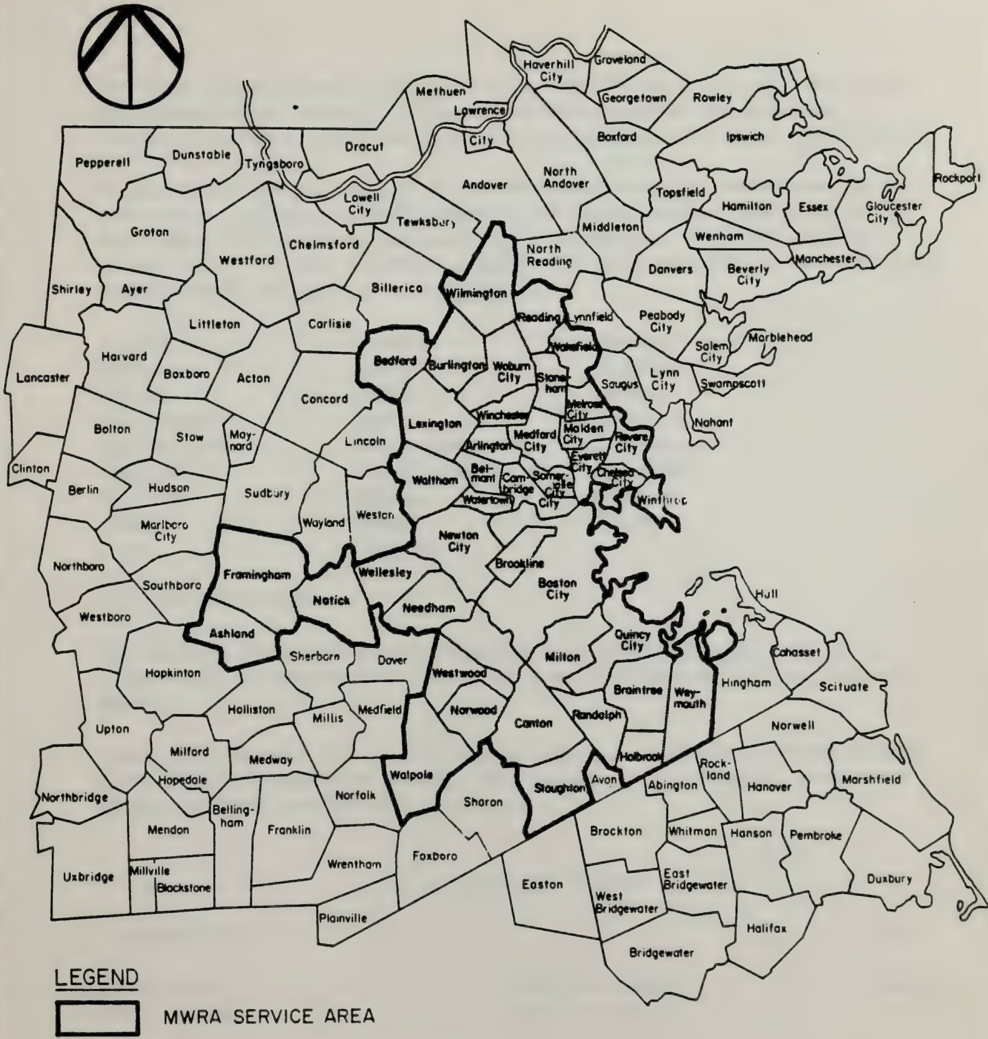
Under its enabling legislation, MWRA is charged with providing treatment to the wastewaters generated in 43 municipalities and special districts. The legislation permits permanent sewer service to other communities, but only after these communities have shown that no feasible alternatives exist, and after numerous regulatory and legislative approvals have been obtained.

Expansion of the service area, if it takes place, will occur at the boundaries of the existing service area. Figure 4.2-1 shows the existing service area, together with communities which are adjacent to the boundary of the area. Most of the communities abutting the Authority's service area are already served by a wastewater system. Any system expansion which might be considered would be on a very limited basis due to existing wastewater utilities on the perimeter of the MWRA service area. Therefore, in developing population and flow projections, the existing service area was used as a base.

Currently, MWRA owns and operates two wastewater treatment plants, one at Deer Island and the other at Nut Island, which handle wastes from the North and South Metropolitan Sewer Service Areas. Some communities in the service area are serviced by both plants. At present, the system provides preliminary and primary treatment, which consists of screening and grit removal, sedimentation, and chlorination. Both the treated effluent and concentrated, digested sludges are discharged into Boston Harbor.

The Nut Island Facility (servicing the South System) has been in operation since 1952 and presently serves the following twenty-one communities:

Ashland	Hingham (N. Sewer Dist.)	Quincy
Boston (portion)	Holbrook	Randolph
Braintree	Milton (portion)	Stoughton
Brookline (portion)	Natick	Walpole
Canton	Needham	Wellesley
Dedham	Newton (portion)	Westwood
Framingham	Norwood	Weymouth



MASSACHUSETTS WATER RESOURCES AUTHORITY	**FIGURE 4.2-1 MWRA SERVICE AREA**

The Southern System encompasses an area of approximately 240 square miles and presently has a total population of approximately 750,000 and a contributing population of approximately 630,000. Five MWRA pumping stations are located throughout the South System contributing area.

The Deer Island Facility (servicing the North System) has been in operation since June 1968 and serves twenty-six communities. The area served by this treatment plant is approximately 170 square miles with a total population of approximately 1,300,000 and a contributing population of approximately 1,250,000. Six MWRA pumping stations are located throughout the North System contributing area. Member cities and towns include:

Arlington	Lexington	Stoneham
Bedford	Malden	Wakefield
Belmont	Medford	Waltham
Boston (portion)	Melrose	Watertown
Brookline (portion)	Milton (portion)	Wilmington
Burlington	Newton (portion)	Winchester
Cambridge	Reading	Winthrop
Chelsea	Revere	Woburn
Everett	Somerville	

4.2.1 DATUM PLANES

The base elevation to be utilized in the facilities plan is the MDC Sewer Datum. This is compatible with the datum previously used for the existing Deer Island and Nut Island treatment facilities.

Various datum planes are used in the Boston area, most commonly Mean Sea Level Datum (USGS datum of 1929), Boston City Base, and the MDC Sewer Datum. The relationship of the various datums to the MDC Sewer Datum are shown below:

DATUM PLANES

To Convert From	To	Add
USGS Datum	MDC Sewer Datum	105.62 ft
Boston City Base	MDC Sewer Datum	99.97 ft

4.3 GUIDELINES FOR COST EVALUATION

In order to use cost-effectiveness comparisons of the treatment alternatives considered for detailed analysis, these guidelines for unit process cost evaluation and procedures for determining life-cycle costs have been developed based on EPA cost-effectiveness guidelines.

Common parameters to be used in all cost effectiveness comparisons include design lives, discount rate, salvage values, and base year for analysis.

Life-cycle cost factors have been prepared for the outfall project, the inter-island conveyance project, the design and construction of the primary treatment facilities, and the design and construction of the secondary treatment facilities due to the phased construction. The derivation of these factors and the common parameters used in the development of these factors are explained in the following paragraphs.

4.3.1 DISCOUNT RATE

At the start of each fiscal year, EPA establishes the discount rate to be used for life-cycle cost analyses. The rate to be used for this analysis is 8-5/8 percent, the rate established by the Water Resources Council as of October 1, 1985.

Several of the events on the life-cycle cost diagram do not occur at one year intervals. Because of this, the life-cycle cost analysis factors generated for the facilities planning have been developed using a monthly discount rate of 0.71875 percent (8-5/8 percent divided by 12), and payments have been divided into monthly periods.

4.3.2 BASE YEAR AND PLANNING PERIOD FOR ANALYSIS

The base month selected for the cost analysis is January, 1990. The year 1990 represents the first year of projected construction activity for primary treatment facilities. Although the projected start-up for construction is not until July of that year, it was considered much easier to use the beginning of the year as a base rather than seven months into the year.

The end of the life cycle of the project will be January, 2020. This provides for 20 years of operation of the completed secondary treatment facilities.

4.3.3 CONSTRUCTION COST INDEX

The construction costs used are based on September, 1986 prices. The Construction Cost Index, as presented in the Engineering News Record (ENR-CCI) for September, 1986, is 4332.5. To simplify, use 4330 for the baseline cost index.

4.3.4 COST ESCALATION FACTORS FOR ENERGY USE AND WASTEWATER FLOW INCREASES

There will be no escalation of energy or chemical costs for the purposes of the cost-effectiveness comparisons. Cost escalation for energy and chemicals will be considered as part of a sensitivity analysis. Different rates will be used to determine potential impacts on total present worth costs of the relative ranks of alternatives. None of the costs will be weighted according to flow. It is unlikely that one alternative would have an appreciably higher flow-dependent cost than another. In addition, the average flow in 1986 is

approximately 93 percent of the ultimate average flow. This difference in flow is not enough to warrant a difference in number of staff. And the difference in energy and chemical requirements would not be appreciable.

4.3.5 LIFE EXPECTANCIES

The life expectancies of cost items are important for use in determining future replacement costs and salvage values at the end of the project period. The life expectancies to be used for these projects are as follows: 5 years for vehicles; 15 years for all equipment; and 50 years for buildings, structures, and pipelines.

4.3.6 LAND COSTS

The MWRA either owns or is statutorily permitted to use all land on Deer Island. The cost of land is not expected to become a part of the life cycle cost analysis. The land requirements are independent of the treatment process selected since all excess area will serve as a buffer zone. Also, in accordance with the cost effectiveness guidelines, the land values must be salvaged at the end of the planning period and therefore would be negligible in the final cost effectiveness comparison. Therefore, there is no need to consider land costs in the life-cycle cost analysis.

4.3.7 PROJECT COSTS

The term "project cost" is used throughout the discussion of cost factors. This cost consists of the estimated capital construction cost plus the cost of engineering and contingencies. The sum of engineering and contingency costs was estimated to be 35 percent of the installed cost. In other words, the estimated installed cost of an item will be multiplied by a factor of 1.35 to yield the project cost.

4.3.8 INTEREST DURING CONSTRUCTION

Interest during construction was calculated based on the following:

- o Uniform cash flow over construction period (therefore, constant gradient of interest payments)
- o Discount rate of 8-5/8 percent per year
- o Monthly payments of interest due
- o No investment dividends on borrowed money not yet paid on the project
- o Gradient series of interest payments converted to annual and then present worth cost

4.3.9 ANNUAL COST

Annual costs are those costs paid each year to keep the facilities in good operating order and to preserve the lives of structures and equipment. The following items, among others, are included:

- Wages and salaries
- Maintenance items
- Energy consumption
- Chemicals

The labor cost for the plant's operation and maintenance staff, including fringe benefits, averages $30,000 per year. The annual maintenance cost which includes lubrication oils, replacement parts, and other maintenance items, is estimated at one percent of the equipment capital costs. The cost of electric power is $0.055/kwh. Chemical costs for the biological treatment alternatives include gaseous hydrochloric acid for cleaning the diffuser discs of the fine bubble diffused air and coupled system alternatives. Chemicals are also required for the disinfection alternatives. For one alternative, sodium hypochlorite must be purchased, while for onsite sodium hypochlorite generation, nitric acid is used for cleaning the generation cells. For the two disinfection alternatives using sodium hypochlorite, dechlorination may be determined necessary. If this is the case, then sodium bisulfite would have to be purchased. The unit costs for the hydrochloric acid is $65 per ton. The unit cost for the sodium hypochlorite is $0.35 per gallon; $7.10 per gallon for the nitric acid; and $0.36 per gallon of sodium bisulfite.

4.3.10 BASIS OF COST COMPARISON

All cost comparisons are made in terms of present worth costs instead of equivalent annual costs. This has been done to avoid confusion between equivalent annual costs and annual operating and maintenance costs. Present worth costs provide a convenient method to evaluate one time capital costs and the annual costs of the alternatives on an equivalent basis. Relative rankings of alternatives will not change whether present worth or equivalent annual cost is the method of comparison.

Table 4.3.10-1 has been prepared with both 1990 and the start-up date of the individual item as base years. Present worth factors at the start-up date have been prepared because in the case of secondary treatment, translating future costs to present worth makes them appear deceptively low.

TABLE 4.3.10-1
SUMMARY OF LIFE-CYCLE COST FACTORS

Item	Factor For Present Worth at Base Year-January 1990
Outfall Project	0.77 Cout +6.99 Aout
Inter-Island Conduit	0.76 Ctun +6.66 Atun
Primary Treatment Facilities Project	0.94 Cpe +0.76 Cps +2.01 Cpv +6.35 Ap
Secondary Treatment Facilities Project	0.61 Cse +0.50 Css +1.03 Csv +4.03 As

Notes:

1. Final Project Month = January, 2020
2. Discount Rate = 0.71875% per month (based on 8-5/8% per year)
3. Abbreviations
   - Cout - Project Cost of Outfall
   - Aout - Annual Maintenance Cost for Outfall
   - Ctun - Project Cost of Inter-Island Conduit
   - Atun - Annual Maintenance Cost For Inter-Island Conduit
   - Cpe - Project Cost of Primary Treatment Equipment
   - Cps - Project Cost of Primary Treatment Buildings Structures, and Pipelines
   - Cpv - Project Cost of Primary Treatment Vehicles
   - Cse - Project Cost of Secondary Treatment Equipment
   - Css - Project Cost of Secondary Treatment Buildings, Structures, Pipelines
   - Csv - Project Cost of Secondary Treatment Vehicles
   - Ap - Annual Operations and Maintenance Cost for Primary Treatment
   - As - Annual Operations and Maintenance Cost for Secondary Treatment
4. Life Expectancies

Equipment	15 Years
Buildings, Structures, Pipelines	50 Years
Vehicles	5 Years

Section 5

5.0 BASIS FOR ANALYSIS OF CANDIDATE OUTFALL SITES

5.1 ANALYTICAL APPROACH TO OUTFALL SITING

This section describes the basis for the outfall evaluation program. The purpose of this section is to describe how candidate sites are compared, what the general design assumptions are, and how the field program and data analyses are used to conduct the comparisons.

A description of the criteria used to evaluate each candidate outfall location is included, as well as a summary of how acceptability for each criterion is measured. Following the criteria is a description of the assessments used to examine candidate sites in relation to their ability to meet specific siting criteria.

5.2 OUTFALL EVALUATION CRITERIA

5.2.1 OVERVIEW OF CRITERIA

For all project components, MWRA has developed criteria to evaluate the alternatives under consideration. Additionally, criteria specifically designed to evaluate outfall alternatives for the discharge of the Deer Island effluent have been used. These criteria were developed in consultation with the Facilities Planning Citizens' Advisory Committee (FPCAC), and scientists serving as advisors to the facilities planning efforts. These criteria were developed separately to permit more specific response to the concerns articulated by the public-at-large, the FPCAC, and the subcommittee of the CAC which has been convened to deal specifically with outfall siting and evaluation issues. Additionally, these criteria can provide the means for continued dialogue with the Executive Office of Environmental Affairs (EOEA) Technical Advisory Group (TAG). The evaluation criteria also recognize the regulatory requirements with which the Authority must comply.

The outfall evaluation criteria have two purposes. First, they establish a method for presenting the relevant characteristics of each candidate site considered, permitting each site to be independently evaluated against issues of concern. Secondly, the criteria display differences between sites, facilitating an assessment of the relative benefits and costs of the sites being considered.

The criteria are used as site evaluation tools but are not always applied specifically at the outfall locations. For example, EPA Water Quality Criteria are applied to areas immediately around the diffuser (herein referred to as the mixing zone), whereas the "Protection of Recreational Areas" criterion is applied to the recreational areas, such as beaches, throughout the study area. Each criterion has been developed with a specific resource in mind and is applied to areas where the resource is both present and useable, or where it might exist in the future.

These outfall evaluation criteria are also used to assess and compare the candidate outfall locations through the evaluation of the impacts of both an interim primary effluent discharge and a long-term secondary effluent discharge.

Effluent quality and diffuser construction are not considered to be variables in the outfall siting assessment. The primary and secondary effluent quality is defined by the influent characterizations and the treatment process efficiencies described in Volumes II and III, respectively, of the Secondary Treatment Facilities Plan (STFP). The outfall tunnel and diffuser design considerations are described in Appendices D and E of this Volume. It was assumed that effluent pumping facilities would not be required for all sites under consideration, but would be necessary for sites more distant than those evaluated.

5.2.2 DESCRIPTION OF OUTFALL EVALUATION CRITERIA

In formulating the proposed criteria, consideration has been given to the specific concerns of the public--notably the concerns expressed by the CAC Outfall Subcommittee. The criteria also reflect the regulatory requirements that must be addressed in all wastewater planning studies. The MWRA submitted these criteria to the Secretary of Environmental Affairs on August 3, 1987, and they were noticed in the Environmental Monitor on August 26 and September 11, 1987. Comments on the criteria were received from several groups and agencies and the Secretary's Certificate of Compliance with the Massachusetts Environmental Policy Act was dated October 2, 1987. The comments presented several suggestions for alternative criteria and many useful thoughts as to how the criteria should to be interpreted. After careful consideration, however, the criteria have not been modified, since all suggestions are incorporated into the proposed criteria.

CAC Outfall Subcommittee Concerns

The CAC Outfall Subcommittee identified two different types of concerns that are relevant to the siting issue: those issues relating to the impacts on the marine environment caused by an outfall placed at different locations; and those issues related to the degree of difficulty associated with designing and constructing the outfall at alternative locations. The first set of concerns has been labeled impact concerns, while the second has been labeled engineering concerns. The specific concerns set forth by the subcommittee are as follows:

Impact Concerns	Engineering Concerns
o Safety and Palatability of Finfish and Shellfish to Consumers	o Reliability
o Protection and Propagation of Aquatic Life	o Flexibility
o Protection of Shellfish	o Constructibility
	o Operational Complexity

- Protection of Bathing Areas and Other Recreational Uses
- Protection of Commercial On-the-Water Activities
- Maintenance and Enhancement of Aesthetic Conditions
- Avoidance of Important Habitats
- Power Needs
- Traffic
- Impact of Catastrophic Failure
- Impact on Historical Resources
- Present Worth Costs, including Capital and Operating Costs

Regulatory Requirements

The regulatory requirements that must be addressed by MWRA include conformance with the Commonwealth of Massachusetts Water Quality Standards, and compliance with general facilities planning guidelines issued by grant-funding agencies.

The Massachusetts Water Quality Standards are issued by the Division of Water Pollution Control (DWPC) of the Department of Environmental Quality Engineering. The regulatory requirements are published in the Code of Massachusetts Regulations (CMR) Section 314. The purposes of the Water Quality Standards are to enhance the quality and value of the water resources of the Commonwealth, and to secure the benefits of the Federal Clean Water Act. To do this, the standards establish classes of marine waters that reflect different designated uses ranging from SA to SC. SA is the highest-use class, and is the class established for all waters under consideration as candidate outfall locations. Class SA waters are designated for the following uses:

- Protection and propagation of fish, other aquatic life, and wildlife.
- Primary and secondary contact recreation. Primary contact recreation includes swimming and water skiing; secondary contact recreation includes all other activities where contact with the water is incidental or accidental.
- Shellfish harvesting from approved areas without depuration.

In order to determine if a body of water meets its designated uses class, the DWPC has established several criteria concerning the characteristics of the water, some of which are quantitative and others which are qualitative. The criteria applicable to Class SA water are described in Table 5.2.2-1.

TABLE 5.2.2-1
COMMONWEATLH OF MASSACHUSETTS
WATER QUALITY STANDARDS FOR CLASS SA WATERS

The following minimum criteria are adopted and shall be applicable to all waters of the Commonwealth, unless criteria specified for individual classes are more stringent.

Parameter	Criteria
1. Aesthetics	All waters shall be free from pollutants in concentrations or combinations that: a) Settle to form objectionable deposits; b) Float as debris, scum, or other matter to form nuisances; c) Produce objectionable odor, color, taste, or turbidity; d) Result in the dominance of nuisance species.
2. Radioactive Substances	Shall not exceed the recommended limits of the United States Environmental Protection Agency's National Drinking Water Regulations.
3. Tainting Substances	Shall not be in concentrations or combinations that produce undesirable flavors in the edible portions of aquatic organisms.
4. Color, Turbidity, Total Supended Solids	Shall not be in concentrations or combinations that would exceed the recommended limits on the most sensitive receiving water use.
5. Oil and Grease	The water surface shall be free from floating oils, grease and petrochemicals, and any concentrations or combinations in the water column or sediments that are aesthetically objectionable or deleterious to the biota are prohibited. For oil and grease of petroleum origin the maximum allowable discharge concentration is 15 mg/1.
6. Nutrients	Shall not exeed the site-specific limits necessary to control accelerated or cultural eutrophication.

TABLE 5.2.2-1
COMMONWEATLH OF MASSACHUSETTS
WATER QUALITY STANDARDS FOR CLASS SA WATERS
(Continued)

7. Other Constituents	Waters shall be free from pollutants alone or in combinations that: a) Exceed the recommended limits on the most sensitive receiving water use; b) Injure, are toxic to, or produce adverse physiological or behavioral responses in humans or aquatic life; or c) Exceed site-specific safe exposure levels determined by bioassay using sensitive resident species.

Additional Criteria

The following additional minimum criteria are applicable to coastal and marine waters for Class SA waters.

Parameter	Criteria
1. Dissolved Oxgen	Shall be a minimum of 85 percent of saturation at water temperatures above 77° C (25° C) and shall be a minimum of 6.0 mg/1 at water temperatures of 77° C (25° C) and below.
2. Temperature	None except where the increase will not exceed the recommended limits on the most sensitive water use.
3. pH	Shall be in the range of 6.5-8.5 standard units and not more than 0.2 units outside of the naturally occurring range.
4. Total Coliform Bacteria	Shall not exceed a median value of 70 MPN per 100 ml and not more than 10% of the samples shall exceed 230 MPN per 100 ml in any monthly sampling period.

Facilities planning guidelines issued by both federal and state agencies set forth general issues that must be addressed in the planning documents. The broad objective of a facilities plan is to conduct a systematic evaluation of feasible alternatives so that the recommended alternative is environmentally sound and cost-effective. Facilities planning guidance documents define cost effectiveness as "the most economical means of meeting the applicable effluent, water quality and public health requirements... while recognizing environmental and other nonmonetary considerations." Within this broad context, individual facilities plans are developed around the unique aspects of the individual project. The facilities planning requirements address many of the engineering concerns articulated by the CAC Subcommittee.

Outfall Evaluation Criteria Selection

The initial step in the development of specific outfall criteria was to convert the concerns expressed by the CAC as well as and the regulatory requirements into various measures of acceptability. The following sections set forth the key criteria developed by MWRA to be used as measures of acceptability.

One criterion or more has been identified for each of the concerns expressed by the CAC Outfall Subcommittee, with the exception of "Impact of Catastrophic Failure." A criterion has not been proposed for this type of event for two reasons. First, a catastrophic failure that resulted in the complete loss of the functional treatment capacity of the plant would, of necessity, result in raw sewage discharges along the inner Harbor waterfront, not at the outfall. This is because the entire flow through the plant is pumped prior to any treatment, and a catastrophic failure at the plant would eliminate any wastewater discharge from the facility. Second, the discharge of partially-treated sewage, resulting from failure of the secondary or primary facilities, is reasonably represented by the evaluation of the impacts of primary treatment.

Additionally, criteria have been included that respond to regulatory restrictions, e.g. water quality requirements and facilities planning requirements. The proposed outfall criteria and the specific concerns that they address, shown in Table 5.2.2-2, are described in the following paragraphs. A detailed description of the techniques to be employed to assess each criterion is contained in Section 5.4, Analytical Approach.

Environmental Outfall Criteria

Ability to Meet EPA Ambient Water Quality Criteria

The EPA Ambient Water Quality Criteria are used to evaluate the potential for adverse impact to marine biota and human health from constituents present within the primary and secondary effluent. This criterion measures the degree to which the EPA Ambient Water Quality Criteria (Quality Criteria for Water, U.S. Environmental Protection Agency, May 1, 1986, EPA 440/5-86-0001) are met for primary and secondary treatment. Alternatives are rated "Excellent," "Good," "Average," "Fair," or "Poor," based on their ability to meet the Water Quality Criteria at the edge of the mixing zone for both primary and secondary treatment under critical conditions, and the degree to which these criteria are met in terms of "safety

TABLE 5.2.2-2

CAC ENVIRONMENTAL CONCERNS AND OUTFALL EVALUATION CRITERIA

Concerns	EPA Criteria	Mass. Water Quality Stds.	Sediment	Local Species	Important Habitat	Taste & Odors	Coliform Criteria	Aesthetics	Shoreline Impacts	Commercial On-the-Water Activities
Safety & Palatability of Finfish & Shellfish	X	X		X	X	X	X			X
Protection & Propagation of Aquatic Life	X	X	X	X	X					
Protection of Shellfish	X	X	X	X	X	X	X			
Protection of Bathing Areas & Recreation							X	X	X	
Protection of Commercial On-the-Water Activities	X	X	X	X	X	X	X			X
Maintenance & Enhancement of Aesthetics								X	X	
Avoidance of Importance Habitats					X					

factors." The Water Quality Criteria result in 60 tests, and each site is assessed as to its ability to meet these 60 tests. This criterion is one of the criteria used to address the concerns identified as Safety and Palatability of Finfish and Shellfish, Protection and Propagation of Aquatic Life, Protection of Shellfish, and Protection of Commercial On-the-Water Activities, as it relates to the protection of fisheries.

Conformance with Massachusetts Water Quality Standards

Massachusetts Water Quality Standards are used to evaluate the potential for adverse impact on marine biota from conventional pollutants from the primary and secondary effluent. Sites are rated "Excellent," "Good," "Average," or "Poor," based on their ability to meet Water Quality Standards for both primary and secondary treatment. No safety factor is considered in this assessment. This criterion is used to address the concerns of Protection and Propagation of Aquatic Life, Protection of Shellfish, and Protection of Commercial On-the-Water Activities, as it relates to the protection of fisheries.

Avoidance of Adverse Sediment Accumulation

This criterion measures the likelihood that sedimentation effects will induce stress in biota, as a result of deposition of contaminated material from the secondary wastewater discharge. Alternatives are rated "Excellent," "Good," "Average," "Fair," or "Poor," based on predicted sedimentation rates from a discharge at a particular site and the potential for a particular site to be located within a short- or long-term depositional area (as measured by sediment grain size and photographic evaluation). This criterion is used to address concerns about Protection and Propagation of Aquatic Life, Protection of Shellfish, and Protection of Commercial On-the-Water Activities, as it relates to the protection of fisheries.

Avoidance of Areas of Important Habitat

This criterion is a measure of the impacts on resources that are important to the regional ecosystem and are of limited geographic distribution. Alternatives are rated as having "Excellent," "Good," "Average," "Fair," or "Poor," ratings based on the distance to known spawning areas, unique marine habitats, and commercial fisheries. This criterion is used to address concerns about the Protection of Commercial On-the-Water Activities and the Avoidance of Important Habitats.

Ability to Protect Local Species from Adverse Stress

This criterion measures the degree to which locally important species may be stressed by a wastewater discharge at a particular site. Alternatives are rated "Excellent," "Good," "Average," "Fair," or "Poor," based on their existing successional infaunal characteristics, ability to meet aquatic life water quality criteria and Massachusetts Water Quality Standards, avoidance of important habitats, sediment accumulation characteristics, and the diversity of the benthic community. This criterion is used to address concerns about Protection and Propagation of Aquatic Life, Protection of Shellfish, and Protection of Commercial On-the-Water Activities.

Ability to Meet Water Quality Criteria to Prevent Taste and Odors

This criterion measures the extent to which chemical-specific criteria are met for constituents that can cause objectionable taste and odor. Alternatives are rated "Excellent," "Good," "Average," "Fair," or "Poor," based on their ability to meet specific criteria for organoleptic contaminants. This criterion is used to address concerns about the Safety and Palatability of Finfish and Shellfish, Protection of Shellfish, and Protection of Commercial On-the-Water Activities.

Conformance with State Coliform Standards

State Coliform Standards are used to evaluate the impact of a wastewater discharge on the ability to harvest shellfish, and the extent to which contact recreation can occur at known recreational areas. Alternatives are rated "Excellent," "Good," "Average," "Fair," or "Poor," based on their ability to meet State Coliform Standards at the edge of the mixing zone. This criterion is used to address concerns about the Safety and Palatability of Finfish and Shellfish, the Protection of Shellfish, the Protection of Bathing Areas, and the Protection of Commercial On-the-Water Activities.

Maintenance and Enhancement of Aesthetic Conditions

This criterion is used to evaluate the potential for adverse impacts to the aesthetic conditions of the region, as measured by excessive increases in primary productivity. Sites were rated "Excellent," "Good," "Average," "Fair," or "Poor," based on the frequency with which an effluent plume would be expected to reach the surface, the nutrient loadings to the Bay, dispersive characteristics of a site, and the potential for nuisance algal blooms. This criterion is used to address concerns about the Protection of Bathing Areas and Other Recreational Areas, and Maintenance and Enhancement of Aesthetic Conditions.

Protection of Shoreline Areas

This criterion is used to evaluate the regional impacts of discharge at each candidate site as measured by the effluent dilution at each sensitive shoreline area. Sites are rated "Excellent," "Good," "Average," "Fair," or "Poor," based on the amount of floatable solids reaching sensitive shoreline areas, effluent dilution at each shoreline, viral contamination at the shorelines, and maintenance of aesthetics. This criterion is used to address concerns about the Protection of Bathing Areas and Other Recreational Areas, and Maintenance and Enhancement of Aesthetic Conditions.

Protection of Commercial On-the-Water Activities

This criterion seeks to measure the potential of any candidate site to avoid physical constraints on commercial activities. Specific measures include potential for the diffuser to interfere with navigation, and potential for interference with commercial fishing (dragging, traveling, gillnetting, lobstering). Alternatives are rated "Excellent," "Good," "Average,"

"Fair," or "Poor," based on the relative abundance and catch from commercial fishing and shellfishing activities, proximity to each site, and the actual commercial activity occurring at a particular site. This criterion is one of several factors used to address concerns about the Protection of Commercial On-the-Water Activities.

Protection of Marine Archaeology

This criterion measures the potential impacts that candidate outfall locations might have on historic/archaeological areas within Massachusetts Bay. Alternatives are rated "Excellent," "Good," "Average," "Fair," or "Poor," based on the likelihood of the existence of historical shipwrecks within a three-mile radius of the outfall location. Generally, reported shipwrecks are most frequent in areas closest to shipping lanes, such as the North Shipping Channel.

Construction Traffic and Noise

This criterion is used to assess the ease of controlling noise generated by construction activities and minimizing traffic impacts. The construction methodology employed at all outfall sites is similar; the noise impacts associated with the candidate outfall locations differ only in terms of the duration of the construction period.

Engineering Criteria

These criteria address the operational, design, and construction considerations for each phase of this project. The engineering criteria have been organized into three general categories: technical, cost, and institutional. Where appropriate, indicators for each criterion have been listed. The criteria have not been weighted, nor has one specific set of criteria been given greater significance than another. Rather, the criteria are used to convey sufficient information about each alternative so that decisions can be made for selecting a recommended plan.

Reliability

Reliability is defined as the level of assurance that the alternative will continuously operate over the expected range of operating conditions throughout the life of the project. Reliability is a criterion in selecting and arranging active components of the systems, such as electrical and mechanical equipment. Alternatives are rated using five levels of reliability: "Excellent," "Good," "Average," "Fair," or "Poor." Alternatives ranked "Excellent" are expected to operate continuously without interruption of system operations. Alternatives ranked "Average" can be expected to have infrequent interruptions of system operations.

Flexibility

Flexibility is defined as the inherent ability to respond to future conditions, such as changes in water quality standards. Alternatives are rated "Excellent," "Good," "Average," "Fair," or "Poor."

Constructibility

Constructibility is defined as the level of assurance that the alternative can be constructed on schedule. It is also a measure of the ease and risk associated with alternative forms of construction. Constructibility is a criterion used in evaluating the transport conduit alternatives: buried marine pipeline versus deep rock tunnels. This criterion includes availability of labor skills, equipment, and material; proven, as opposed to state-of-the-art, construction methods; the impact of adverse weather; and a general assessment of the likelihood of encountering unknowns. Alternatives are rated as presenting "Excellent," "Good," "Average," "Fair," or "Poor" conditions for construction, based on their ability to comply with court-ordered target dates.

Operational Complexity

Operational complexity is defined as the degree of difficulty in the maintenance and control of a given alternative. Operational complexity reflects the levels of skill and attention required by plant operators to successfully operate the facilities. For this study three levels of operational complexity are cited: "Typical," "Moderate," and "Difficult." "Typical" operational complexity means that the system equipment and controls employed require skills similar to those required in typical municipal treatment facilities.

Power Needs

The total electrical power requirements for each alternative are presented in terms of kilowatts. The costs of electrical power are significantly influenced by the magnitude of peak demand periods. Thus, the demand factors for each of the alternatives will be considered. Power will not be required for any of the alternatives being evaluated.

Quantity and Quality of Spoils for Disposal and/or Relocation

Construction of new transport and treatment facilities requires the movement of large quantities of soil and subsequent disposal and/or use at either on-island or off-island locations. For this study, the total volume (yd^3) of spoils requiring movement and the volume (yd^3) requiring off-site disposal and/or reuse are presented for each alternative. In addition, material that will require off-site disposal will be assessed based on the type and quality of material and the difficulty expected in ultimately disposing of it.

Cost Criteria

These criteria measure the financial resources that must be invested in the facilities. For all other parts of the Deer Island STFP, costs are classified as capital, operations and maintenance, and present worth. In this specific case, only capital costs are considered because the alternatives involve only gravity-flow systems, which involve essentially no operating costs.

Capital Costs

Capital costs of alternatives include costs to construct facilities, and costs for equipment replacement during the planning period plus 35 percent to cover construction contingencies, administrative, engineering and legal costs. Any significant and special mitigation cost is included in the alternative costs. Construction costs of necessary facilities in this plan do not include costs for land purchase. Financing, legal, and administrative costs to implement the project are presented only for the recommended plan. Capital costs are presented in terms of millions of dollars.

Institutional Criteria

These criteria cover those areas related to the implementation of the STFP. Those criteria common to all project components include:

Timely Implementation

Implementation is defined as the relative difficulty expected in maintaining the schedule for installation and/or expansion of the system in discrete, manageable components. For this study, three ratings are appropriate for this criteria: "Modest," "Moderate," and "Difficult." For alternatives with features likely to cause project delays, the "Difficult" rating is used. For other alternatives posing fewer challenges, the "Modest" rating is used.

Permitting

Permitting is defined as the measure of the relative difficulty in obtaining the necessary permits for an alternative. The alternatives are rated "Moderate" or "Extensive," reflecting the number and types of approvals required.

External Coordination Requirements

External coordination requirements are a measure of the relative degree to which MWRA must interact with other organizations to achieve the desired objectives. These include considerations of legislative approval and other requirements necessitated by legal and jurisdictional limits to MWRA's authority. Alternatives are rated "Minimal," "Modest," or "Extensive," depending on the degree of coordination required.

Internal Coordination Requirements

Internal coordination requirements are a measure of the relative degree of coordination required between MWRA projects or programs, such as the coordination required between the wastewater treatment section and the industrial waste section. Alternatives are rated "Minimal," "Moderate," or "Extensive," depending on the degree of coordination required.

Demand for Unique or Scarce Resources

This criterion is a measure of the demand that any one alternative may put on resources that are in scarce supply or not available in the local area. Key shortages of some labor skills and equipment may occur because of the concurrent construction of major projects such as the Third Harbor Tunnel. Alternatives are rated "Moderate" if potential conflicts exist, or "Difficult" if demands clearly exceed supply.

5.3 OUTFALL EVALUATION CONSIDERATIONS

Selection of a recommended outfall plan involves two elements: a determination of the most appropriate location for the outfall; and a decision on what type of facilities to construct to reach that point. Selecting the location primarily involves comparing the predicted impacts of the discharge on important marine resources, measured by application of the environmental criteria. Determining how to reach that location involves alternative engineering considerations, measured primarily by the technical and institutional criteria, but also includes considerations of environmental issues. The purpose of this section is to present, in summary format, the approach used in conducting environmental evaluations as part of the outfall planning process.

5.3.1 OUTFALL SYSTEM CONCEPTUAL DESIGN ASSUMPTIONS

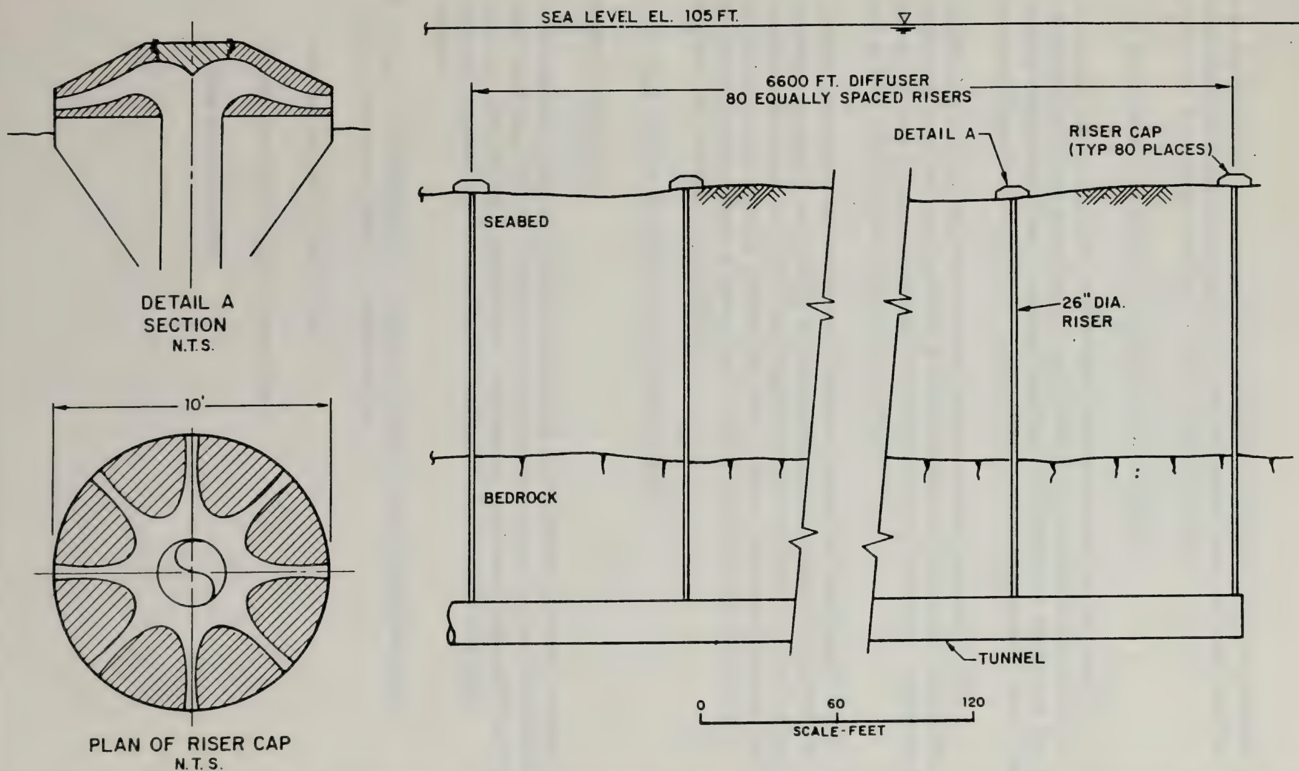
The outfall system required to convey treated effluent from Deer Island to the ocean will consist of an outfall conduit and a diffuser. The outfall conduit transports the treated effluent from Deer Island to the diffuser. The diffuser discharges the effluent near the ocean bottom, nearly uniformly, over a length of approximately 6,600 ft.

The recommended outfall system for each candidate site is similar. Each includes a vertical access shaft located on Deer Island; a single, gravity-flow, deep rock, concrete-lined tunnel; and a diffuser consisting of 80 individual vertical risers equally spaced over a distance of 6,600 ft. A cross-sectional view of the diffuser, which is similar for all sites, is shown in Figure 5.3.1-1.

A tunnel was selected as the recommended conduit, based on a cost comparison with marine pipelines and sunken tubes. A summary of the selection of the outfall conduit is given in Section 7, Evaluation of Outfall Alternatives. Design considerations are summarized in Section 8, Detailed Evaluation of the Recommended Plan, and in Appendix E. A multi-riser diffuser was selected based on a cost comparison with other alternatives.

Marine Impacts

Because a deep rock tunnel is the method of choice for the outfall, there will be no dredging required inshore of the diffuser. The diffuser will be constructed using one of two types of drilling rigs; a jack-up or a semi-submersible rig. The only areas of the ocean bottom disturbed will be those areas adjacent to the riser. For each candidate outfall site, the outfall system and construction techniques will generally be the same: a rock tunnel followed



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 5.3.1-1
TYPICAL DIFFUSER CROSS SECTION

by an 80-riser diffuser. This assures that the comparison of candidate outfall sites using the environmental and engineering criteria can be made on a similar basis with regard to diffuser construction. A schematic of the outfall system is shown in Figure 5.3.1-2.

5.3.2 FUTURE MWRA EFFLUENT QUANTITY AND QUALITY

The proposed Deer Island secondary wastewater treatment plant will have the capacity to treat an average of 390 million gallons per day (mgd) under low groundwater conditions, and an average of 670 mgd under high groundwater conditions. The effluent, on average, will have a biochemical oxygen demand (BOD) of 15 mg/l, and the level of suspended solids will be 15 mg/l.

The effluent will also contain nonconventional pollutants including heavy metals, volatile organics, pesticides, and other materials. A detailed discussion of the flows and contaminant loads can be found in Volume II, Facilities Planning Background. Summaries of the contaminant loads are shown in this section in Tables 5.3.2-1 and 5.3.2-2.

The future wasteloads of nonconventional pollutants are estimated to be the same as the current wasteloads. In actuality, as a result of the industrial pretreatment program to be undertaken by MWRA, future wasteloads will be lower than current loads. However, since the results of the pretreatment program cannot be predicted adequately at this time, the current loads are used here as a conservative estimate of future loads. It should be noted that increased future flows have been reflected in these estimates.

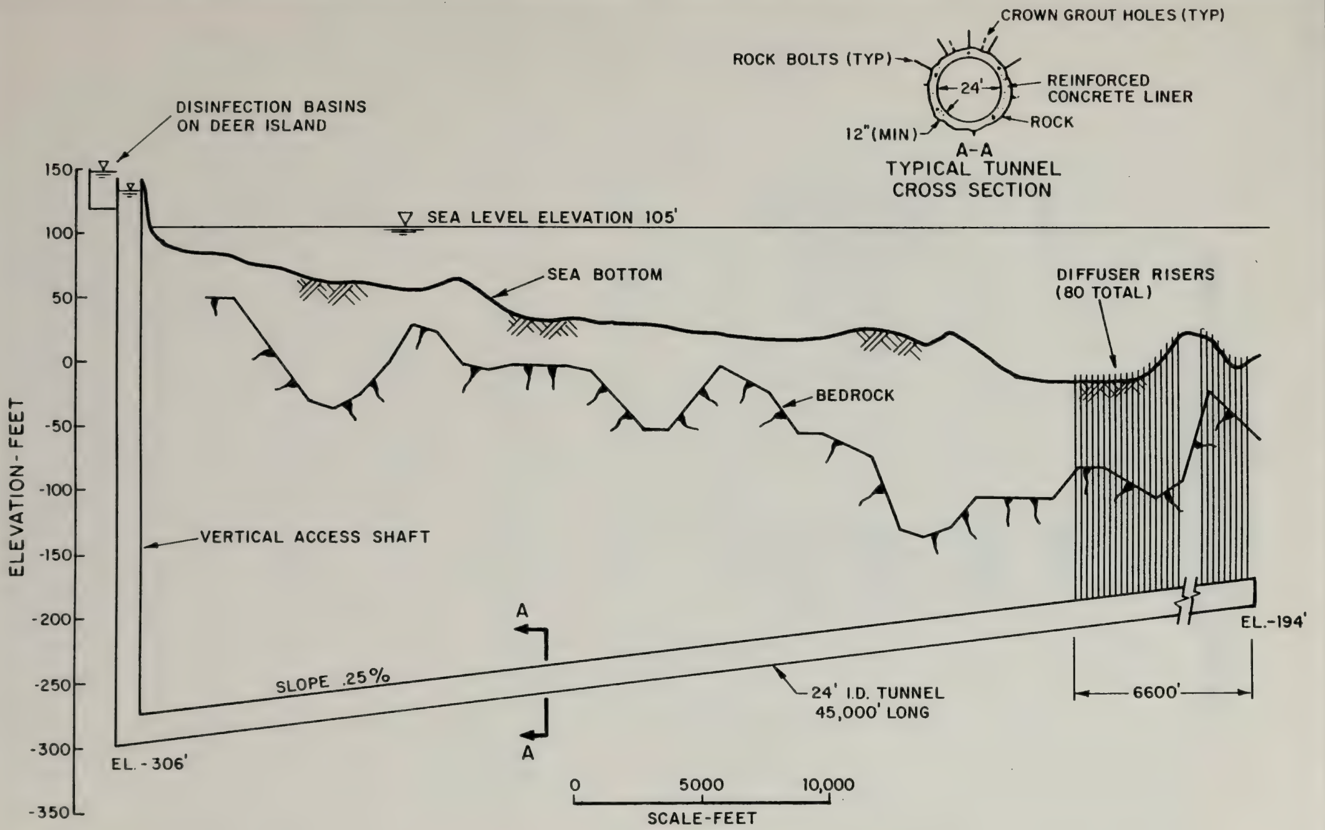
5.3.3 EVALUATION OF THE MARINE ENVIRONMENT

Physical Oceanography

An understanding of the physical characteristics of Massachusetts Bay is extremely important to outfall siting because dilution, dispersion, and sedimentation are major mechanisms influencing the concentration and fate of contaminants. Understanding how these processes differ between sites is an important factor in the evaluation of the impacts and suitability of candidate locations.

Wastewater effluent discharged to a receiving water body, such as Massachusetts Bay, undergoes three distinct phases of transport and fate:

- near-field mixing, or initial dilution;
- intermediate-scale transport and impacts; and
- far-field transport and fate.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.3.1-2
OUTFALL SYSTEM SECTION

TABLE 5.3.2-1
PROJECTED WASTEWATER CHARACTERISTICS
CONVENTIONAL POLLUTANTS

Parameters	Influent
BOD	15 mg/L
S.S.	15 mg/L
pH	6.5 - 8.5
Temperature	56° - 70° F
Alkalinity	97.42 mg/L
Total Coliform/100 ml	700/100 ml
Fecal Coliform/100 ml	200/100 ml
Ammonia Nitrogen	13.54 mg/L
Total Phosphorus	1.80 mg/L
Silicate	6.45 mg/L

TABLE 5.3.2-2

PROJECTED WASTEWATER CHARACTERISTICS
NON-CONVENTIONAL POLLUTANTS

Constituent	Average Mass Load Existing Influent (lbs/day)	Average Mass Load Projected Influent (lbs/day)	Maximum Projected Influent (lbs/day)	Treatment Removal Efficiency Primary	Treatment Removal Efficiency Secondary	Projected Primary Effluent Average (lbs/day)	Projected Primary Effluent Maximum (lbs/day)	Projected Secondary Effluent Average (lbs/day)	Projected Secondary Effluent Maximum (lbs/day)
Phenol	54.0	64.2	128.7	20%	95%	51.4	103.0	3.2	6.4
Benzyl Alcohol	69.3	86.3	147.8	NA	90%*	86.3	147.8	8.6	14.8
1,2-Dichlorobenzene	65.1	74.8	128.4	NA	90%	74.8	128.4	7.5	12.8
2-Methylphenol	71.0	88.4	134.0	NA	90%*	88.4	134.0	8.8	13.4
4-Methylphenol	61.2	76.3	134.0	NA	90%*	76.3	134.0	7.6	13.4
Benzoic Acid	269.4	335.5	681.5	NA	90%*	335.5	681.5	33.5	68.2
Naphthalene	45.3	52.5	118.2	0%	95%	52.5	118.2	2.6	5.9
2-Methylnaphthalene	49.6	61.8	128.2	NA	90%*	61.8	128.2	6.2	12.8
2,4,5-Trichlorophenol	349.0	401.0	621.1	NA	90%*	401.0	621.1	40.1	62.1
Dimethyl Phthalate	69.6	80.2	124.8	24%	95%	60.9	94.9	4.0	6.2
Diethyl Phthalate	57.1	67.3	125.1	0%	90%	67.3	125.1	6.7	12.5
N-Nitrosodiphenylamine	69.3	86.3	135.3	NA	69%	86.3	135.3	26.8	42.0
Di-n-butyl Phthalate	57.9	68.4	129.5	0%	90%	68.4	129.5	6.8	12.9
Butylbenzyl Phthalate	54.0	63.7	120.5	0%	95%	63.7	120.5	3.2	6.0
Bis(2-ethylhexyl) Phthalate	67.8	78.3	124.4	0%	90%	78.3	124.4	7.8	12.4
Di-n-octyl Phthalate	57.0	65.8	115.2	0%	90%	65.8	115.2	6.6	11.5

Notes: Average daily flow is expected to increase from 208 mgd to 239 mgd. Protected low and high Groundwater Flows are 390 mgd and 670 mgd, respectively.

Sources: Report to Congress on the Discharge of Hazardous Waste to POTW, Forty Cities Report, Seattle Study, 30-Day Study, Treatability Manual.

TABLE 5.3.2-2

PROJECTED WASTEWATER CHARACTERISTICS
NON-CONVENTIONAL POLLUTANTS
(Continued)

Constituent	Average Mass Load Existing Influent (lbs/day)	Average Mass Load Projected Influent (lbs/day)	Maximum Projected Influent (lbs/day)	Treatment Removal Efficiency Primary	Treatment Removal Efficiency Secondary	Projected Primary Effluent Average (lbs/day)	Projected Primary Effluent Maximum (lbs/day)	Projected Secondary Effluent Average (lbs/day)	Projected Secondary Effluent Maximum (lbs/day)
Antimony	10.8	16.2	23.1	30%	60%	11.4	16.1	6.5	9.2
Arsenic	6.0	7.6	12.3	25%	50%	5.7	9.2	3.8	6.2
Boron	1261.2	1570.5	7655.6	2%	5%	1539.1	7502.5	1492.0	7272.8
Cadmium	7.1	8.4	14.8	15%	50%	7.2	12.6	4.2	7.4
Chromium	75.8	88.5	157.4	40%	76%	53.1	94.5	21.2	37.8
Copper	345.1	399.8	639.3	35%	82%	259.8	415.6	72.0	115.1
Cyanide, Total	53.9	112.0	169.8	10%	60%	100.8	152.8	44.8	67.9
Lead	49.9	69.5	130.2	46%	57%	37.5	70.3	29.9	56.0
Mercury	4.1	5.0	17.5	22%	75%	3.9	13.6	1.2	4.4
Molybdenum	17.1	21.3	47.2	10%	50%	19.2	42.4	10.7	23.6
Nickel	66.0	79.1	149.8	15%	32%	67.2	127.3	53.8	101.8
Selenium	35.2	53.3	153.9	10%	50%	47.9	138.5	26.6	76.9
Silver	15.5	18.0	26.8	30%	90%	12.6	18.8	1.8	2.7
Zinc	738.8	866.2	2840.1	40%	76%	519.7	1704.0	207.9	681.6

Notes: Average daily flow is expected to increase from 208 mgd to 239 mgd. Protected low and high Groundwater Flows are 390 mgd and 670 mgd, respectively.

Sources: Report to Congress on the Discharge of Hazardous Waste to POTW, Forty Cities Report, Seattle Study, 30-Day Study, Treatability Manual.

TABLE 5.3.2-2
PROJECTED WASTEWATER
NON-CONVENTIONAL POLLUTANTS
(Continued)

	Average Mass Load		Maximum	Treatment		Projected		Projected	
	Existing	Projected	Projected	Removal Efficiency		Primary Effluent		Secondary Effluent	
	Influent	Influent	Influent			Average	Maximum	Average	Maximum
Constituent	(lbs/day)	(lbs/day)	(lbs/day)	Primary	Secondary	(lbs/day)	(lbs/day)	(lbs/day)	(lbs/day)
Bromomethane	54.3	62.3	106.8	NA	95%	62.3	106.8	3.1	5.3
Methylene Chloride	104.7	120.3	293.3	0%	95%	120.3	293.3	6.0	14.7
Acetone	337.1	419.7	1088.6	NA	95%	419.7	1088.6	21.0	54.4
Carbon DiSulfide	27.5	34.3	53.1	NA	95%	34.3	53.1	1.7	2.7
trans-1,2-Dichloroethe	25.6	29.9	48.1	36%	90%	19.1	30.8	3.0	4.8
Chloroform	17.6	22.3	42.8	NA	90%	22.3	42.8	2.2	4.3
2-Butanone	82.5	102.8	211.8	NA	90%*	102.8	211.8	10.3	21.2
1,1,1-Trichloroethane	41.8	49.7	92.1	40%	95%	34.9	72.0	2.2	4.5
Trichloroethene	36.2	43.6	90.0	20%	95%	34.9	72.0	2.2	4.5
Benzene	12.5	16.5	22.6	0%	95%	16.5	22.6	0.8	1.1
4-Methyl-2-Pentanone	64.7	80.5	139.7	NA	90%*	80.5	139.7	8.1	14.0
Tetrachloroethene	47.4	61.7	134.0	0%	90%	34.3	49.3	3.4	4.9
1,1,2,2,-Tetrachloroeth	29.4	34.3	49.3	NA	90%	34.3	49.3	3.4	4.9
Toluene	60.8	71.3	160.9	0%	90%	71.3	160.9	7.1	16.1
Chlorobenzene	28.0	33.8	52.2	NA	90%	33.8	52.2	3.4	5.2
Ethylbenzene	28.8	33.4	63.7	0%	95%	33.4	63.7	1.7	3.2
Styrene	30.1	37.5	55.7	0%	90%	37.5	55.7	3.8	5.6
Total Xylene	85.9	107.0	255.0	NA	95%	107.0	255.0	5.3	12.7

Notes: Average daily flow is expected to increase from 208 mgd to 239 mgd. Protected low and high Groundwater Flows are 390 mgd and 670 mgd, respectively.

Sources: Report to Congress on the Discharge of Hazardous Waste to POTW, Forty Cities Report, Seattle Study, 30-Day Study, Treatability Manual.

During initial dilution, the momentum and buoyancy of the discharged wastewater are expended in the ambient receiving waters, as large quantities of ambient water are entrained. The process is governed by the dynamics of the discharge jet and the characteristics of the receiving water, including stratification and current speed. It is also important to understand and quantify these near-field dynamics because most state and federal water quality criteria are required to be met at the end of this process.

Beyond this initial mixing zone, the effluent is mixed into the receiving waters to the point where density and velocity differences between the wastewater plume and ambient waters are negligible. From there, the wastewater plume begins to be transported and spread out by intermediate-field processes, measured over the period of several tidal cycles. At this scale, tidal dynamics, wind drift, and stratification become important, because of the possibility of the plume being transported to an important resource area such as a beach or shellfish bed. Sedimentation processes must also be understood to determine local impacts on benthic organisms.

The far-field transport and fate phase occurs over a much larger area than the other phases. The wastewater plume is assimilated by Massachusetts Bay or is flushed to the Gulf of Maine. This fate may include sediment deposition to areas of net accumulation, or the build-up of water column concentrations due to the discharge of effluents over large periods of time, as affected by flushing from the Bay, or biochemical removal.

Thus, a physical oceanography program has been developed with the following goals in mind:

- to provide an improved understanding of the coastal system in which the outfall will be located, as well as the fate and transport of the effluent from the outfall;

- to develop quantitative and qualitative data on the characteristics of candidate sites as input to the evaluation of sites, as well as to the evaluation of the nature and extent of impacts of the selected site.

Section 5.4.2 describes the field studies and analyses used to assess the physical oceanographic aspects of outfall siting. Section 6.4.1 describes the results of the physical oceanography program and how they affect the siting process.

Chemical and Biological Oceanography

Protection of the environment also allows the flexibility to manage available resources and to provide the greatest possible benefits from those resources. With this in mind, a chemical and biological oceanography program has been developed and is described in Section 5.4.3, Marine Resources Impact Assessments. The results of the programs are detailed in Sections 6.4.2 and 6.4.3 of this Volume.

The chemical oceanography program was designed to assess existing water quality in Massachusetts Bay and to assist in the modeling efforts which evaluate the relative impact of a wastewater discharge at each candidate outfall location on the Bay.

The purpose of the biological oceanography program was to describe, as closely as possible, the existing ecology of the Bay, and to assist in the environmental impact assessment of the recommended plan.

5.4 ANALYTICAL APPROACH

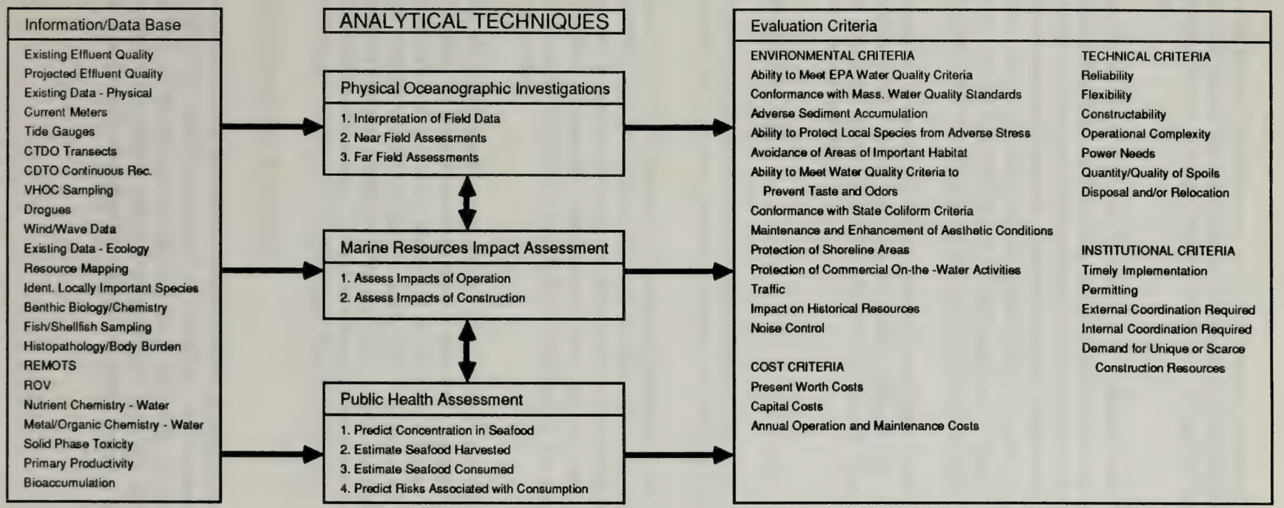
5.4.1 OVERVIEW OF METHODOLOGY

The general approach to the detailed evaluation of candidate outfall sites and construction technologies is to first collect an adequate data/information base from existing sources and from necessary field programs. This data/information base is used to define baseline conditions upon which predictions of future changes resulting from the new discharge from Deer Island can be made. Analytical tools and scientific and engineering principles are used to predict how each candidate outfall site performs against the evaluation criteria. Environmental evaluation criteria are addressed using fate and transport analyses, marine resource impact assessments, and a public health assessment. A schematic of the overall evaluation process is shown in Figure 5.4.1-1. The marine field program that served, together with existing data, as the primary data base for the assessment of environmental criteria is described in detail in Appendix GG. Cost criteria were analyzed using the cost guidelines issued by the state and federal grant agencies. Engineering specialists evaluated the technical criteria through evaluation of the various alternatives. Institutional criteria were addressed using evaluations performed by engineering, construction, and management specialists familiar with the technology and permitting required for this project and related projects within and external to MWRA. The assessment of each criterion wase summarized in matrix form, without weighting, for discussion for final site selection by the MWRA Board.

5.4.2 FATE AND TRANSPORT

Overview

In order to determine how well a particular candidate outfall site meets the outfall siting criteria described in Section 5.2, and to compare sites on the basis of these criteria, some quantifiable measure of the anticipated results from the discharge of treated effluent at each of the outfall sites had to be developed. Many of the criteria involved predictions of future contaminant concentrations in the water column resulting from discharges from the MWRA system and other systems. A description of the analytical techniques used for prediction and the anticipated types of results follows. Appendix A contains a detailed discussion of the techniques and modeling results.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.4.1-1
GENERAL ANALYTICAL APPROACH OCEAN OUTFALL EVALUATION

For the purposes of this discussion and in the interest of simplicity, the transport mechanisms are those that govern the movement of a substance or contaminant in the environment, while the fate mechanisms are those that govern any physical or chemical changes that the substance may undergo.

The analyses can be divided into four categories: collection of field data; evaluation/interpretation of field data; near-field assessments; and far-field assessments. Each category is discussed separately below. Some of these analyses generate outputs that become inputs to other analyses, while some generate outputs that directly respond to specific evaluation criteria. For example, the results of the harmonic decomposition of the current meter and tide data become inputs to the calibration of the TEA-NL and ELA models; and the results of the TEA-NL and ELA simulations in predicting the far-field contaminant

concentrations were used to compare candidate outfall sites under the criteria of "Protection of Shoreline Areas." More generally, as shown in Figure 5.4.1-1, some of the outputs from the fate and transport analyses also become inputs to the marine resources impact assessment and the public health assessments.

Field and Existing Data

Existing data from previous studies and data collected as part of the physical and chemical oceanography field programs are used as inputs to the three types of analyses.

Existing data consist, for example, of information contained in the Boston Harbor Data Management Report (EPA Contract No. 68-04-1009; Metcalf & Eddy; Nov. 1983), and from previously collected density profiles, which can be used as input to the initial dilution analysis and the plume height-of-rise analysis. Data collected from the field program for Phases I and II of these studies were evaluated and interpreted as described in the next section, Marine Resources Impact Assessments.

Field data collection efforts involve deployment of physical oceanographic equipment such as current meters, tide gauges, and continuously-recording conductivity/temperature/dissolved (CTDO) oxygen probes to better understand the physical processes in Massachusetts Bay. Collection of water column samples was used to determine ambient water quality conditions, and collection of influent wastewater samples was used to define the quality of material to be discharged to the environment. These data collection efforts are described in detail in this Volume in Section 6, Existing Conditions and Field Investigations.

Evaluation/Interpretation of Field Data

These analyses involved the interpretation and display of much of the raw data collected through the field program, and are not, of themselves, used to assess a site based on the outfall criteria. The evaluation involved: calculating density and salinity from the conductivity and temperature data; estimating the tidal excursion and net circulation at each candidate outfall site to determine the degree of advective flushing; harmonic decomposition of

the current meter and tide data; determining the correlation and coherence between the wind and tide data to assess the effect of wind stress on circulation; and the coherence between Boston Harbor circulation and the circulation in Broad Sound. The actual output from these evaluations is a series of graphical displays that enhance the interpretation of modeling results. All of the analyses in this group produced outputs that were used in the near-field and far-field assessments.

Near-Field Assessments

Near-field assessments evaluate processes that occur very close to the outfall, within 600 or so feet, and over very short time periods, generally within 10 minutes of discharge. The area encompassed by these assessments is often called the zone of initial dilution, or the mixing zone. EPA's initial dilution model, ULINEA, was used to conduct the near-field analyses. Input parameters included seawater and effluent density, current velocity, depth of effluent discharge, and diffuser size and alignment to calculate initial dilution at the edge of the mixing zone and trapped plume rise height for stratified conditions.

The outputs from these analyses were used to determine the ability of each site to meet EPA Water Quality Criteria and Massachusetts Water Quality Standards. This information was also used as input to marine resources impact studies and public health assessments. It compared candidate outfall sites on the basis of more qualitative outfall siting criteria. The plume height-of-rise analysis yielded information on the magnitude and seasonal duration with which the plume will surface, and was used to assess the Maintenance and Enhancement of Aesthetic Conditions criteria, among others.

Far-Field Assessments

Far-field assessments evaluate the fate of the discharge and its associated contaminants as they are moved away from the mixing zone by currents, winds, and tides. These assessments allow an evaluation of effects and impacts at locations distant from the mixing zone. The prediction of far-field concentrations was carried out with the numerical circulation and transport models, TEA-NL and ELA, respectively. The MIT numerical simulation models TEA-NL and ELA were used as far-field simulation tools in this study. TEA-NL is a two-dimensional, frequency domain, finite element circulation model. ELA is a two-dimensional, Eulerian-Lagrangian finite element mass-transport model. Data from the field program were used to calibrate these models. The decomposed tide gauge data were used to set the boundary conditions of TEA-NL. Comparisons of observed current meter data versus the predicted current velocities from the model were used to calibrate TEA-NL. Data from a special sampling program were used to calibrate ELA.

Once these models were calibrated, they were used to predict future concentrations in Massachusetts Bay as a result of discharges from the MWRA system and other sources. The results were used, for example, to estimate the background concentration around the candidate outfall sites and were necessary to conduct the near-field analyses. With these results it was possible to combine various estimates to evaluate interactions and to estimate contaminant

concentrations under different hydrodynamic conditions. Extreme events were simulated by specifying the conditions under which these events could occur; the results of the event were then assessed. By evaluating the individual contributors to the cumulative estimate, it was possible to identify factors that most significantly affect the predicted concentrations.

Estimates of sediment deposition are also possible. The amount of contaminants depositing as sediments is estimated by developing ranges of particle settling velocities indicative of different physiochemical properties. The distribution of the sediments was estimated from current and transport information developed as part of the modeling exercises. It was recognized that the processes of sedimentation are not well understood, that this issue is only now beginning to receive attention in the regulatory environment, and that little is known about the impacts of the quality of accumulated sediments. Nonetheless, these studies provide a basis for comparison of potential sediment impacts among candidate sites.

The results of the far-field modeling were used near-field in two ways: first, as stated above, to predict the background concentrations for input to the frequency distribution analysis; and second, to predict concentrations within Massachusetts Bay, at shoreline areas and at other sensitive receptors. The results were used in the evaluation of criteria directly related to water quality standards and in the comparison to the other qualitative criteria.

5.4.3 MARINE RESOURCES IMPACT ASSESSMENTS

Introduction

Impacts associated with construction and operation (including operational phases) of the Deer Island Secondary Wastewater Treatment Facility effluent system on marine ecological systems were evaluated for each of the candidate outfall locations. This section provides a description of the general analytical approach used to assess marine resources impacts, including an identification of data sources used in the assessments. Construction and operational impacts are treated separately.

Construction-Related Impacts

Construction of the outfall could potentially cause adverse impacts on a number of important marine resources. These include habitat removal or alteration, water quality impacts, and toxicity impacts. A description of the approaches used to evaluate these issues follows.

Habitat Removal

Habitat removal resulting from dredging/excavation will directly affect benthic communities, as well as some local fisheries and shellfisheries. The impact assessment involves an evaluation of the type and amount of habitat to be affected by construction, and the resultant effects on local communities. The following parameters are evaluated: number of organisms lost, potential for recolonization, changes in successional patterns, effects on higher trophic levels, effects on resident spawning species (e.g. representative important species), and

barrier effects on migratory species. Data requirements for this evaluation include the following:

- o Baseline existing conditions information from existing scientific literature or derived from the marine ecology field program, such as the benthic infaunal sampling, ROV cruises, fish/shellfish sampling, resource mapping, and REMOTS surveys;

- o Life history data for dominant species derived from NMFS, Bigelow and Schroeder, etc.;

- o Data on composition and abundance of regional species derived from other Massachusetts Bay studies.

In addition, information on construction sequencing (timing of dredging activities, duration, mitigation strategies, etc.) was included in the impact analysis to ensure a comprehensive evaluation of impacts and to suggest alternative construction methods as necessary to minimize or mitigate adverse effects.

Water Quality Impacts

The primary water quality impact associated with construction is turbidity. Changes in other water quality parameters such as dissolved oxygen, pH, or suspended solids may also result from these activities. The effects of these changes are evaluated in terms of impacts to local phytoplankton and fish communities. The effects on plankton and primary productivity of turbidity resulting from resuspension of sediments were evaluated in terms of the potential for shading and sedimentation. Effects on local fisheries resulting from changes in DO, suspended solids, and pH were also evaluated. Data requirements for this evaluation included:

- o Baseline existing conditions from existing literature or derived from marine ecology field programs, such as the primary productivity and plankton speciation study, nutrient sampling, fisheries sampling, and physical oceanography (current patterns, velocities, etc.);

- o Scientific literature on environmental factors affecting and/or limiting primary productivity, effects of suspended solids and other water quality changes on fish (e.g., clogging of gills, reduction in composition/abundance of prey species, etc.);

- o Data from other pertinent studies or impacts assessments;

- o Construction sequencing information.

Toxicity Impact

Resuspension of toxic materials as a result of dredging activities can adversely affect marine resources (e.g. benthos, fish, and shellfish) in areas adjacent to construction. An assessment

of the potential for acute toxicity of marine biota caused by metals and organics resulting from resuspension of sediments on marine biota was conducted. In addition, the potential for bioaccumulation of materials contained within the sediments was evaluated.

Data requirements for this evaluation included:

- Baseline existing conditions;
- Ambient water column chemistry;
- Results of bulk sediment analyses for metals and organics;
- Results of body burden analyses (flounder only);
- Results of bioassay/toxicity testing (if warranted by bulk sediment analytical results);
- Physical oceanographic data, including current patterns, velocities, etc.

Additional data from the open literature were relied upon to provide corroborating/comparative information. Data such as 96-hr and chronic toxicity concentrations for various species, and Boston Harbor/Mass Bay sediment chemistry data from sources such as NOAA, NEA, MASS DWPC, and MWRA's water transportation (pier) projects, were utilized in the assessment of the effects of dredging on water chemistry and marine resources.

Operational Effects

The assessment of the operational effects of the discharge focused on the potential for impairment of the marine ecosystem. Because of physical limitations that essentially preclude concurrent construction of new primary and secondary treatment facilities, the impacts of a discharge of a primary effluent (1995-1999) and secondary wastewater effluent (1999 and onward) on marine resources were evaluated separately. Although it is recognized that there may be differences between the chemical characteristics of primary and secondary effluents, the analytical approaches to the assessment of adverse impacts were essentially the same for both.

Plankton and Primary Productivity

An assessment of the potential for changes in nutrient availability leading to changes in plankton species composition and abundance was conducted. An evaluation of water quality and chemistry changes as they relate to primary productivity, excessive algal blooms, and, ultimately, to eutrophication was made. Shifts in phytoplankton species composition and abundance (e.g. diatoms to chlorophytes) were evaluated in light of predicted water quality/chemistry changes and environmental factors which are known to govern growth and productivity.

Key data requirements for this evaluation included:

- o Baseline existing conditions, derived primarily from plankton and productivity field studies, resources mapping, water quality/chemistry (nutrients) studies, physical oceanographic information characterizing current patterns, velocities, etc.;
- o Results of predictive mathematical modeling that describe concentrations of nutrients (incremental and ambient), plume configuration (e.g. size, depth, stratification, intrusion into the photic zone);
- o Pertinent scientific literature, particularly that which pertains to those environmental factors that limit or accelerate growth and productivity.

Upon completion of the above analysis, each of the candidate outfall locations will then be categorized using the evaluation criteria set forth previously. Specific criteria include:

- o Ability to Meet EPA Water Quality Criteria;
- o Conformance with Massachusetts Water Quality Standards (Class SA);
- o Ability to Meet Water Quality Criteria to Prevent Objectionable Taste and Odors;
- o Maintenance and Enhancement of Aesthetic Conditions;
- o Ability to Protect Local Species from Adverse Stress.

Benthos

As assessment of the potential for toxic effects of wastewater constituents on bottom-dwelling (benthic) organisms was performed. This evaluation included an assessment of the potential for acute and/or chronic toxicity of metals and organics in the water column, and an assessment of the potential for deposition/sedimentation of metals and organics leading to bioaccumulation. Shifts in benthic species composition and abundance as a result of water column/sediment concentrations over time were evaluated, as well as an assessment of what these changes mean at the higher trophic levels (e.g. to fish/shellfish).

Data requirements for this evaluation included:

- o Baseline existing conditions derived primarily from the benthic infaunal sampling, Remotely Operated Vehicles (ROV), REMOTS, fish/shellfish sampling and physical oceanography program;
- o EPA Water Quality Criteria (Gold Book) and Massachusetts Water Quality Standards;

- o Results of predictive mathematical modeling (e.g. concentrations of constituents at the mixing zone, configuration of the plume, sedimentation rates);
- o Concurrent studies (e.g. bioaccumulation rates, bulk sediment analysis, effluent toxicity testing, etc.);
- o Scientific literature describing life history information, community dynamics, pertinent studies, etc.

Upon completion of the above analysis, each of the candidate outfall locations were then categorized, using the following criteria to be utilized in the evaluation of candidate outfall locations:

- o Ability to meet EPA Water Quality Criteria;
- o Conformance with Massachusetts Water Quality Standards;
- o Adverse Sediment Accumulation;
- o Ability to Protect Local Species from Adverse Stress;
- o Protection of Commercial On-the-Water Activities;
- o Avoidance of Areas of Important Habitat.

Fisheries

An evaluation of the potential impact of a wastewater discharge on fisheries resources (e.g. commercially-important species of fish, lobster, crab, and shellfish) was conducted. An assessment of the potential toxicity of metals and organics in the water column was made. Additionally, the potential for accumulation of toxics in sediments over time, and the likelihood of bioaccumulation through water/sediment pathways were evaluated. This evaluation also provided the input required to assess the potential for adverse impacts on human health via ingestion of marine life. Section 5.4.4 discusses the Public Health Assessment in detail.

Potential changes in local species composition, and both beneficial and adverse potential changes in Broad Sound/Massachusetts Bay fishery resources resulting from the presence of the diffuser and effluent, were evaluated and described. Changes that might affect commercial fishing strategies, such as locations, gear types, etc. were addressed for the candidate sites considered.

Primary data requirements for the evaluation of the effects of wastewater discharge on fisheries resources included:

- o Baseline existing conditions derived primarily from field studies such as the benthic sampling, fish/shellfish sampling, ROV cruises, REMOTS surveys, resource mapping;
- o Results of the bioaccumulation study;
- o Results of the predictive mathematical modeling, describing concentrations of metals and organics at the mixing zone and elsewhere in Massachusetts Bay, plume configuration, environmental fate and transport of constituents in the discharge, and speciation of metals;
- o EPA Water Quality Criteria and Massachusetts Water Quality Standards;
- o Other studies such as bulk sediment chemistry, pertinent impact assessments (e.g. South Essex), and other scientific literature.

Upon completion of the analysis described above, each of the candidate outfall locations was then categorized using the appropriate evaluation criteria as set forth in Section 5.2.3, Description of Specific Outfall Evaluation Criteria. Specific criteria include:

- o Ability to Meet EPA Water Quality Criteria;
- o Conformance with Massachusetts Water Quality Standards;
- o Ability to Protect Local Species from Adverse Stress;
- o Avoidance of Areas of Important Habitat;
- o Protection of Commercial On-the-Water Activities.

5.4.4 PUBLIC HEALTH ASSESSMENT

The impact of primary- and secondary-treated effluent on human consumers of marine resources has been evaluated. Because marine organisms that are subjected to organic and metallic contaminants can, in many cases, bioaccumulate these contaminants in their tissues, the public consuming these fish products would, as a result, then be exposed to contaminants that have a potential health effect. Additionally, the public could potentially be exposed to pathogenic bacteria and viruses through dispersion of the discharge plume, which might eventually reach sensitive locations such as bathing beaches.

Potential risk has been evaluated using documented health assessment techniques. Additional site-specific data has also been be evaluated as appropriate. Input to the models was obtained from a variety of field collection efforts, including data on the predicted fate and transport of dissolved, suspended, and settled contaminants; existing populations of pelagic and demersal fish species; current and predicted contaminant uptake into fish and humans; and determination of the quantities of fish and shellfish caught and consumed.

The public health assessment, therefore, received a majority of its input from both the fate and transport and marine resources impact assessment analyses. The approach to the public health assessment has been divided into the following phases:

- o Identification of contaminants of concern;
- o Estimation of the seafood harvest from the impact areas;
- o Prediction of the concentration of contaminants in seafood;
- o Estimation of the number of people who consume seafood from the impact areas;
- o Estimation of the quantity of seafood consumption by the public;
- o Assessment of risk to human health based on consumption;
- o Pathogen assessment.

A detailed discussion of the Public Health Assessment is contained in Appendix C.

Identification of Contaminants of Concern

The first step in the assessment required the identification of specific contaminants of concern from the array of pollutants found in the treated effluent. The selection of pollutants that were evaluated was based upon:

- o Predicted concentration in the effluent;
- o Persistence in the aquatic environment;
- o High bioaccumulation potential;
- o High toxicity to humans.

The primary data requirements were:

- o List of pollutants found in the secondary effluent;
- o Information from the literature on the bioaccumulation potential in marine organisms and toxicity to humans.

This information was used to identify a list of pollutants used throughout the assessment process. A brief toxicity profile was provided for each contaminant, which describes the toxicity and health impact of each pollutant.

Estimated Seafood Harvest

The second step in the public health assessment was to determine the quantity of seafood caught in the study area. The Division of Marine Fisheries was contacted to identify landings from the outer Harbor area. Distributors of seafood in the area were contacted for their characterization of commercial landings. The evaluation of the fisheries data conducted as part of the marine resources impact assessment also provided the necessary input to this analysis. Primary data requirements included:

- Types of species present;

- Use of areas by commercial and by recreational fishermen;

- Production of fisheries within generalized outfall regions. These data were obtained as output from the marine resources impact assessment--specifically the fish and shellfish sampling program.

The fisheries data obtained were used to quantify the contribution of fish and shellfish from the affected areas to the total dietary intake of fish and shellfish by the public.

Predicted Concentrations of Contaminants in Seafood

The next step in evaluation of the potential impact of a wastewater discharge on consumers of fish products was the prediction of the concentrations of contaminants in the edible tissue of these products. The prediction required identification of the contaminant levels to which the organisms are exposed, the physical condition of the species present at each location, and the uptake rates and bioconcentration factors for each contaminant. The primary data requirements for this portion of the assessment were:

- Current concentrations of contaminants in the water column and in the sediments. These data were obtained as output from the marine resources impact assessments, specifically the water column and benthic chemistry sampling program;

- Current fisheries health. These data were obtained as output from the marine resources impact assessments, specifically from the histopathology and contaminant body burden sampling program. (This information, however, is not complete, and will be updated in the final version of the STFP);

- Bioaccumulation rates or bioconcentration factors for each contaminant. These data were obtained as output from the marine resources impact assessment program, specifically from literature values of contaminant uptake rates in native species and from the bioaccumulation study. (This information, however, is not complete, and will be updated in the final version of the STFP);

- o Predicted concentrations of contaminants at known resource areas. These data were obtained as output from the fate and transport analyses.;

- o EPA Water Quality Criteria and Massachusetts Water Quality Standards.

The current water and sediment contaminant concentrations were obtained through actual field and laboratory measurements and the marine resources assessment. The fate and transport section provided the predicted water and sediment contaminant concentrations, and the bioaccumulation study (as well as values from the scientific literature) provided predicted contaminant uptake rates. The predicted concentrations with combined uptake rates provided sufficient data to assess the future contaminant body burden available for human ingestion.

<u>Estimation of the Population Consuming Seafood</u>

Census data was used to identify the population that would actually be exposed to seafood from the study area. The distribution centers to which the fish and shellfish are brought were determined. Identification of the total areas served by the distribution centers (i.e., New Bedford, Gloucester, Boston) allowed for an estimation of the populations exposed.

<u>Estimated Seafood Consumption</u>

The next step in assessing the impact of the discharge on public health was to determine the amount of seafood consumed by the public. Approaches developed in the <u>Guidance Manual for Health Risk Assessment of Chemically Contaminated Seafood</u> (prepared by TetraTech, Inc. for EPA, June 1986) were used to determine the quantity of seafood consumed. Information developed by SRI, Inc. (1980) on the types of seafood consumed was also used.

Primary data requirements included:

- o Quantity of seafood consumed using average and maximum exposure data;

- o Breakdown by species of the different types of fish and shellfish consumed.

These data were used specifically to evaluate how much of the fish and shellfish from the affected areas are actually consumed by individuals.

<u>Health Impacts</u>

The final step in the risk assessment was to determine health impacts on the population consuming seafood obtained from the study area. To perform this assessment, data on predicted concentrations of contaminants in commercial species, and the quantity of seafood from the affected area which was actually consumed, were used to calculate a total dosage of each contaminant. These dosages were then compared to EPA potency factors or reference dose values to estimte carcinogenic risks or other health effects. Primary data requirements used but not fully discussed here are:

- EPA potency factors for carcinogens;
- EPA reference dose values;
- Gastrointestinal absorption rates obtained from scientific literature.

These parameters were combined with the dosage values calculated in the previous steps to predict carcinogenic risk values.

The public health assessment program produced a series of results which identified the potential carcinogenic risks and other health effects associated with consuming fish or shellfish from the study area, and identified differences between the candidate outfall sites in terms of potential public health impacts.

Pathogen Assessment

As a final evaluation, the potential impacts on public health resulting from pathogenic bacteria and viruses were evaluated. This evaluation utilized the results of dispersion modeling, which predicted levels of bacteria and viruses at the time that the plume affects sensitive receptor locations, such as beaches. These values were compared to EPA and other standards for bathing waters to determine if acceptable levels occur.

Conclusion

This public health assessment program produced a series of results that identified the potential carcinogenic risks or other health effects associated with consuming fish or shellfish from within the study area. It also identified any differences among the candidate outfall sites in terms of potential public health impacts. This particular aspect of the program does not lead directly to an assessment of the project criteria but provides an important basis for the acceptability of a particular site for an ocean discharge.

Section 6

6.0 EXISTING CONDITIONS

6.1 INTRODUCTION AND OVERVIEW

This section is a summary of the present environmental conditions of Massachusetts Bay. The information in this section represents the baseline conditions prior to construction of the outfall and the diffuser for the Deer Island treatment plant discharge. Included in this section are descriptions of field collection efforts in support of the outfall siting decision, discussions of the existing marine environment, and the implications for outfall site evaluations.

The field program and data analyses are divided into three categories: physical oceanography, chemical oceanography, and biological oceanography. The field efforts are designed to supplement data available in current scientific literature; their use is described in Section 5.4, Analytical Approach. The results of the field program are interpreted, either in the form of modeling results or in raw data, to determine the ability of each site to meet the siting criteria prescribed for siting the outfall, shown in Section 7, Evaluation of Alternatives. A description of the data collection program and the results of the data analyses are shown below.

6.2 EXISTING FACILITIES

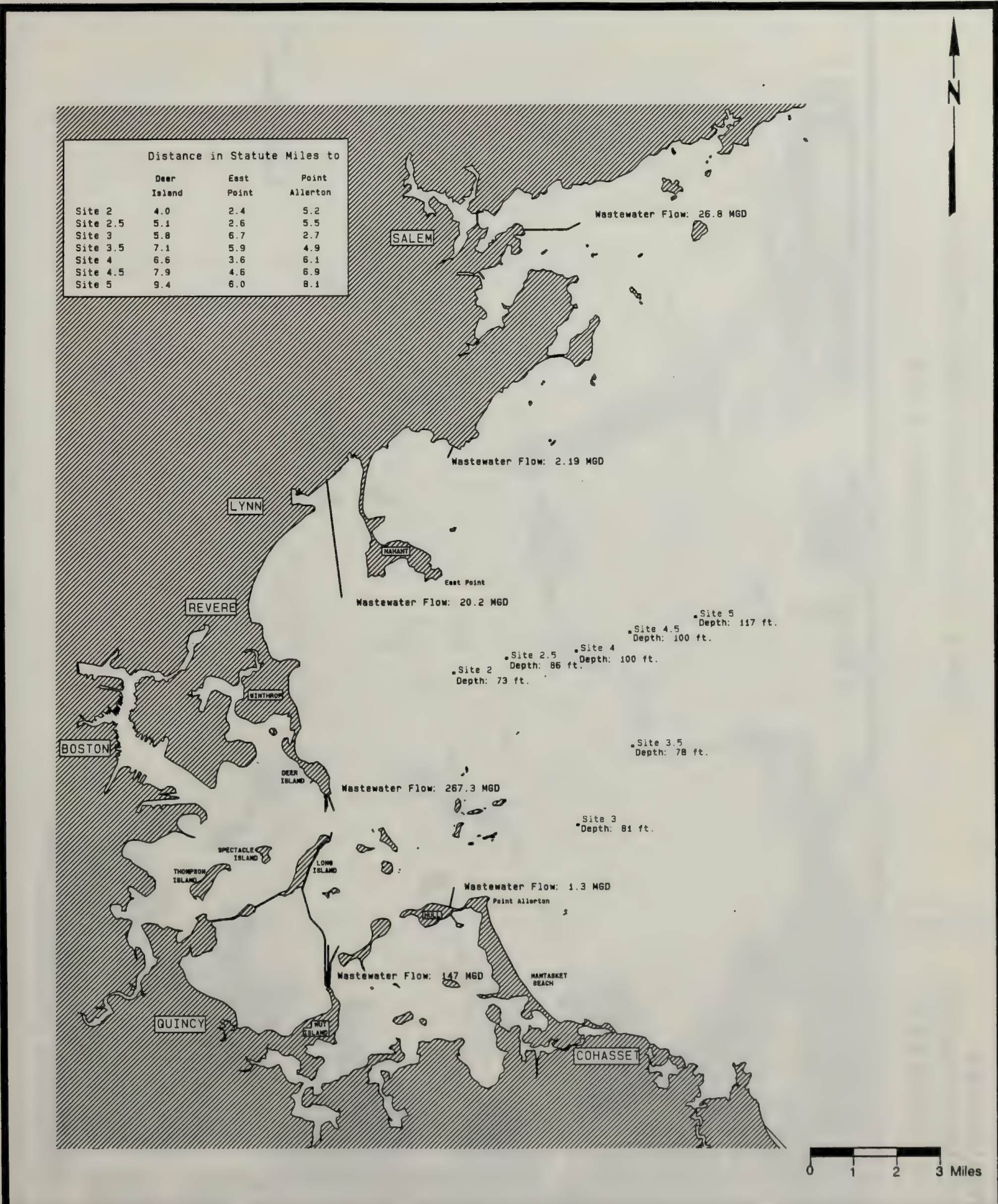
Massachusetts Bay receives wastewater from several sources along its coastline. These include discharges from treatment plants for the MWRA, the South Essex Sewerage District, Swampscott, Lynn, and Hull, as well as numerous combined sewer overflow (CSO) discharges. Figure 6.2-1 shows the region's wastewater treatment plants and their average wastewater flow.

The MWRA wastewater system services 43 communities in Eastern Massachusetts and has two operating primary treatment facilities. One facility is the Nut Island Treatment Plant, which services the MWRA's South System and the other is the Deer Island Treatment Plant, which services the North System.

The service area and the facilities operated by MWRA for the collection and treatment of wastewater have been described in detail in Volume II, Facilities Planning Background. The following section describes the existing MWRA outfalls and the other regional discharges.

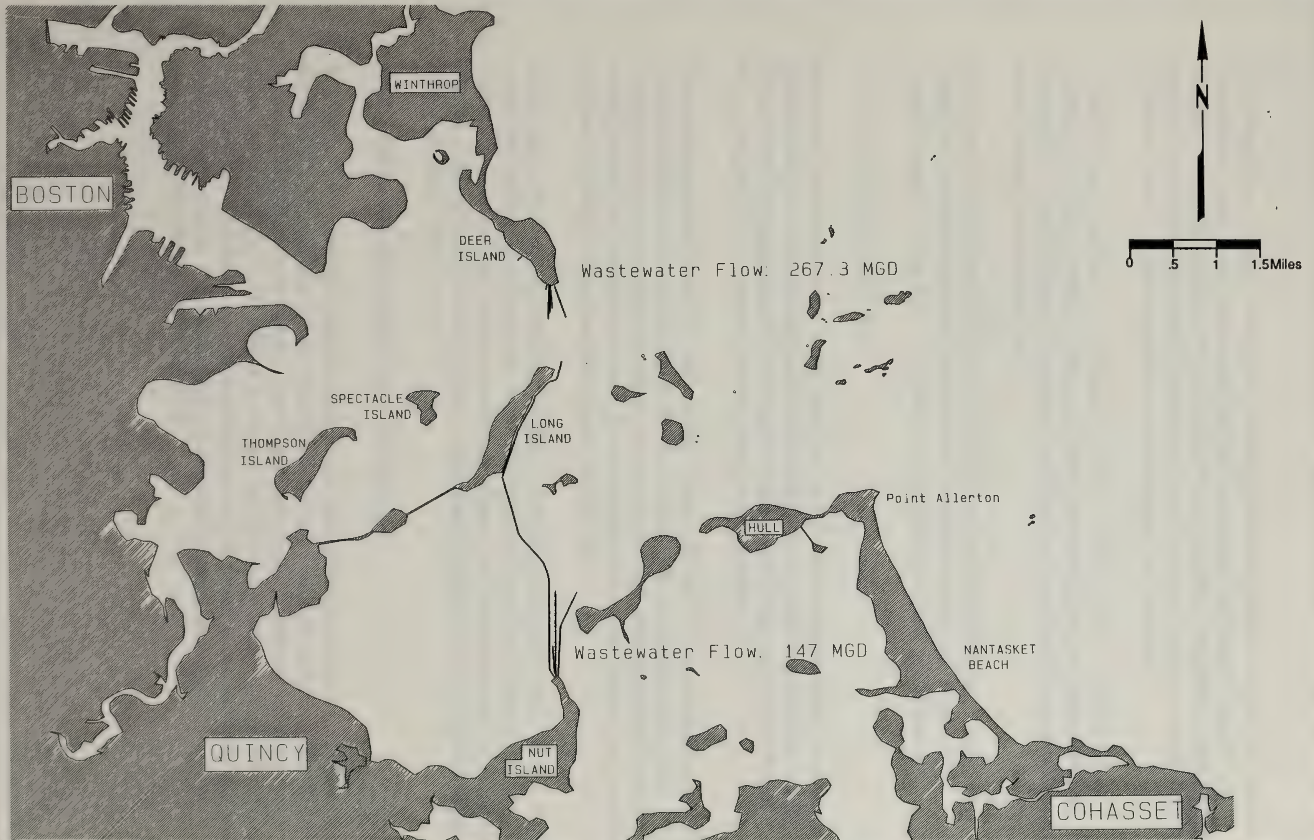
6.2.1 DEER ISLAND OUTFALL

The outfall system at Deer Island comprises two main outfall pipes and three auxiliary outfalls that discharge to the receiving waters at President Roads. These outfall locations are shown in Figure 6.2.1-1.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 6.2-1
REGIONAL WASTEWATER TREATMENT FACILITIES



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 6.2.1-1
MWRA WASTEWATER DISCHARGES

The effluent from the Deer Island plant is discharged through Outfalls 001 and 002 during low tide periods. In the event that plant effluent flow rates exceed the hydraulic capacity of Outfalls 001 and 002, Outfalls 003, 004, and 005 may be used. These three auxiliary outfalls may also be used during periods of extremely high tide. Digested sludge is released through all effluent outfalls, depending on which are operating on any given day.

Outfall 002 was constructed in three phases in 1891, 1895, and 1917. Outfall 003 was constructed in 1916 to serve as a temporary relief outfall during the 1917 construction of Outfall 002. Outfall 002 served as the main outfall at Deer Island until the construction of a primary sewage plant there in 1968.

Outfall 001 was constructed in 1964 during the primary treatment plant construction, with Outfalls 004 and 005 constructed concurrently to serve as relief outfalls. These five outfalls, detailed in Table 6.2.1-1, constitute the existing Deer Island outfall system.

6.2.2 NUT ISLAND OUTFALL

Five outfall pipes make up the outfall system for the Nut Island treatment plant. Four of the pipes discharge into the receiving waters in the vicinity of Nut Island and Peddocks Island, while the fifth discharges anaerobically digested sludge into the outgoing tide at President Roads. Figure 6.2.1-1 shows the location of these discharge points.

The two main outfalls for the Nut Island Plant, Outfalls 101 and 102, were constructed in 1904. A third, Outfall 103, was constructed in 1914 as a relief outfall to supplement the main outfalls during periods of high tide and/or high flows. A sludge discharge line to President Roads, Outfall 105, was added in 1946. The construction of a primary plant at Nut Island in 1952 saw the addition of an emergency bypass, Outfall 104.

By the early 1980s, however, the deterioration in hydraulic capacity of Outfall 101 and 102 had necessitated the continuous operation of the short Outfall 103, and more frequent use of Outfall 104. Accordingly, MWRA undertook the cleaning of Outfalls 101 and 102 in the winter of 1985-86 to restore their hydraulic capacity. Additional information on the Nut Island outfalls is also provided in Table 6.2.2-1.

6.2.3 OTHER MASSACHUSETTS BAY DISCHARGES

In addition to the treatment plant effluent from the Deer and Nut Island plants, combined sewer overflows (CSOs) and effluent from other treatment plants contribute significant quantities of contaminants to Massachusetts Bay. The location of the major treatment plant discharges are shown in Figure 6.2-1. CSO outfalls for Boston and other communities are not shown on this map, however. The relative contribution of effluent and pollutants to Massachusetts Bay varies from source to source. The sections below summarize the importance of each source in evaluating MWRA outfall siting alternatives.

TABLE 6.2.1-1

DEER ISLAND OUTFALL SYSTEM

OUTFALL NUMBER	DESCRIPTION	YEAR BUILT	LENGTH (Ft)	PIPE SIZE (Ft)	PIPE MATERIAL
001	Existing New Outfall	1964	5,454	16 x 11 to 12 x 10 to 10 (diam.)	Concrete RC
002	Existing Old Outfall	1891 1895 & 1917	4,663	6 x 6.25 to 9 (diam.)	Brick w/ concrete encasing
003	Existing Temporary Outfall	1916	1,200	6.5 (diam.) to 5 (diam.)	RC Cast Iron
004	Relief Bypass	1964	500	9 (diam.)	RC
005	Relief	1964	135	9 (diam.)	RC

Source: Metcalf & Eddy, 1982
RC = Reinforced Concrete

TABLE 6.2.2-1

NUT ISLAND OUTFALL SYSTEM

OUTFALL NUMBER	DESCRIPTION	YEAR BUILT	LENGTH (Ft)	PIPE SIZE (Ft)	PIPE MATERIAL
101	Easterly	1904	5,830	60	Cast Iron
102	Westerly	1904	5,545	60	Cast Iron
103	Short	1914	1,412	60	Cast Iron
104	Emergency Bypass	1952	663	60	RC
105	Sludge Line	1946	22,000	12	Cast Iron

Source: Metcalf & Eddy, 1982
RC = Reinforced Concrete

Lynn/Saugus

The primary treatment plant serving the City of Lynn and parts of Saugus and Nahant currently discharges 20 million gallons per day (mgd) of effluent into Lynn Harbor. This is expected to increase to 22.4 mgd by 1998. Based on available sampling data, significant amounts of metals are discharged from the Lynn facility; these are expected to continue for the foreseeable future. The contribution of contaminants to Massachusetts Bay via the Lynn outfall is considered in assessing the viability of MWRA candidate outfall locations.

Swampscott

The town of Swampscott currently discharges primary effluent into Nahant Bay. Flows, as indicated in the town's Revised Section 301(h) Waiver Application (CDM, 1986), are expected to remain at the present rate of 2.19 mgd. The estimated contaminant loadings to Massachusetts Bay after secondary treatment are expected to be relatively small. However, this secondary effluent source (based on the summer 1987 denial of a 301(h) Waiver) has been included in the evaluation of candidate outfall locations for the MWRA Secondary Treatment Facilities Plan (STFP).

South Essex Sewerage District

The South Essex Sewerage District (SESD) presently discharges about 25 mgd of primary treated effluent into Salem Harbor. By the year 2000, the effluent flow rate is expected to reach 26.8 mgd (CDM, 1986). These contaminant loadings to Massachusetts Bay from the SESD facilty will continue to be a significant contributor to its overall contaminant loading. This discharge has been modeled as secondary effluent in the evaluation of candidate outfall sites. The quality of the future effluent is based on the 1987 301(h) Waiver denial.

MWRA Combined Sewer Overflows

More than 11 billion gallons of CSOs and storm runoff enter Boston Harbor and its tributaries annually. Plans to eliminate dry weather overflows and reduce combined sewer overflows are currently being formulated. Because of the magnitude of the mass loadings and the proximity of the inner Harbor to the proposed MWRA candidate outfall sites, these overflows are considered in the outfall evaluation program. They were modeled as a single point source discharging into the Harbor at the mouth of the inner Harbor. Previous studies on the CSO situation for the Neponset River Estuary and Dorchester Bay indicate relatively minor pollutant levels discharged through these sources. These sources have thus been omitted in the MWRA outfall evaluation process.

Hull

Secondary effluent is discharged through the town of Hull's outfall at a rate of about 1 mgd. By the turn of the century, this is expected to approach the plant capacity of 3.07 mgd. Even with the increase in flow rate, the mass of contaminants entering Massachusetts Bay through the Hull outfall is negligible. Because these numbers are so small, and because the Hull outfall

is located far from the majority of the proposed MWRA outfall sites, this contaminant source has not been included in the outfall site evaluation process.

Although most of these sources now discharge partially treated wastewater, the forecasts of future conditions conducted as part of their study have assumed that additional treatment will be provided in the future. It is expected that MWRA will cease the discharge of sludge from the Nut and Deer Island plants in 1991, and that secondary treatment will be provided for Lynn, Swampscott and SESD. Lynn is about to commence construction of its secondary treatment facilities. Both Swampscott and SESD have recently had their 301(h) Waiver Applications denied, and both are conducting facilities planning for secondary treatment. The MWRA is currently developing a detailed contract for evaluation of alternative CSO control strategies.

6.3 FIELD INVESTIGATION PROGRAM

6.3.1 INTRODUCTION

The field program described herein was developed as a result of an assessment of the adequacy of current scientific literature and has evolved through a series of meetings with the EOEA Technical Advisory Group (TAG) and the Citizens' Advisory Committee (CAC). This section is intended to describe only the data collection efforts; the results are described in Section 6.4, Results of Field Investigations.

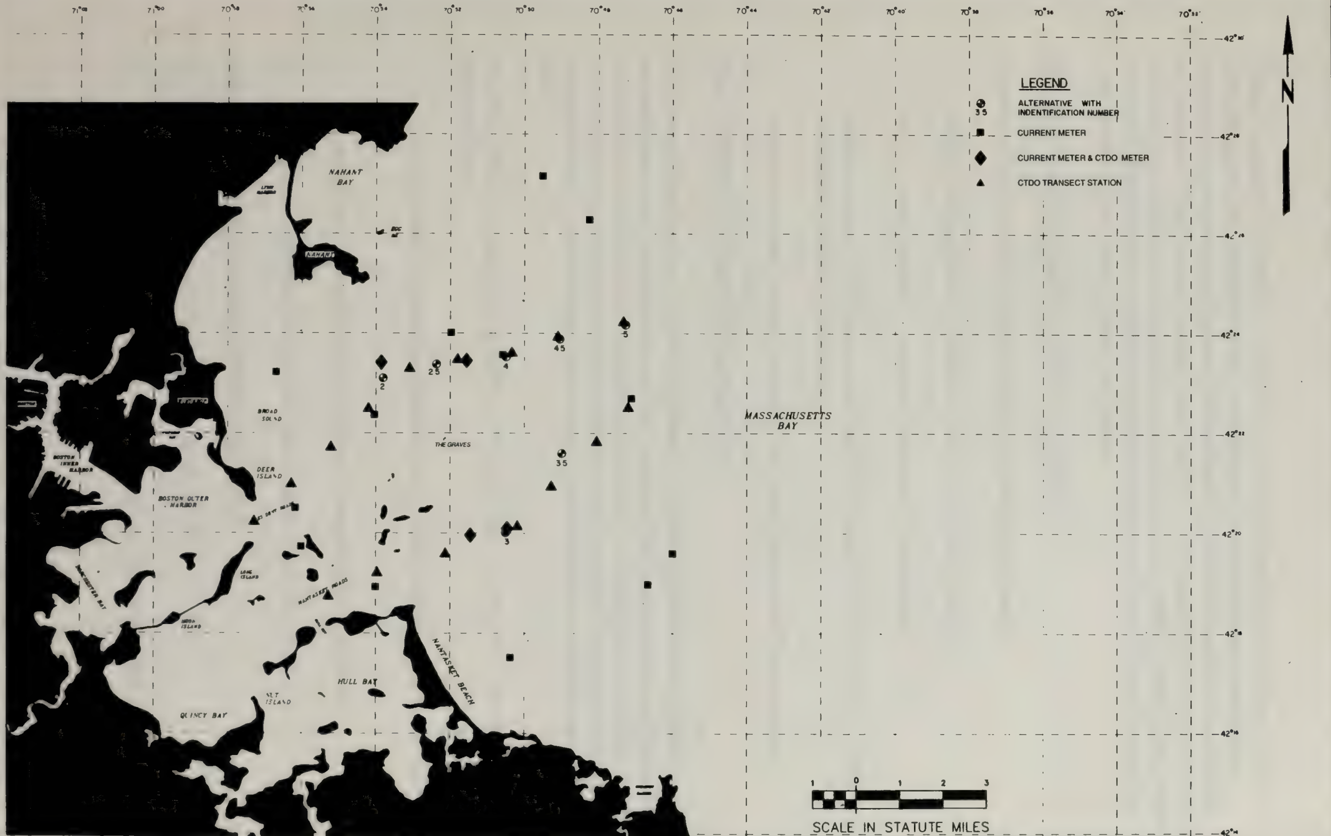
The field investigation program consists of three major categories: physical, chemical, and biological oceanography. Each category is divided into two subcategories: sampling design and field data collection efforts.

6.3.2 PHYSICAL OCEANOGRAPHIC FIELD PROGRAM

A two-phase physical oceanographic field program was conducted as part of the outfall siting program. Phase I was a small-scale preliminary study performed during the summer of 1986 to better focus the efforts of the major data collection program. Phase II was a six-month environmental baseline program conducted from March through August, 1987. A summary of the scope, intent, and results of each data collection component for each phase of the field program is presented in subsequent subsections.

Phase I Physical Oceanographic Sampling Design

Previous data collection efforts were performed primarily in the areas of the existing discharge in President Roads, and the site proposed in the 301(h) Waiver Application, known herein as Site 5. For Phases I and II, the study area was expanded to enhance the current knowledge of the physical oceanography, particularly in the area between outfall Sites 2, 3, and 4. Figure 6.3.2-1 shows the locations of the outfall sites and the physical oceanographic sampling stations.



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 6.3.2-1
PHYSICAL OCEANOGRAPHIC FIELD PROGRAM

In order to rapidly and efficiently supplement the available data in the study area, the Phase I field data collection, described below, was developed. Sampling stations were located particularly in the areas where previous data collection efforts were sparse (in Broad Sound and Nantasket Bight between President Roads and Site 5. The sampling program was designed primarily to investigate far-field effluent transport to determine where an outfall plume would go, and to determine density stratification and dissolved oxygen levels in Massachusetts Bay (particularly in Broad Sound) during the summer.

Phase I Physical Oceanographic Field Data Collection

The Phase I data collection efforts consisted of the following elements:

- o drogue tracking studies to determine short-term (tidal) transport;
- o vertical density profiles to determine the extent of stratification;
- o dissolved oxygen (DO) profiles and Secchi disk measurements to analyze turbidity and conventional pollution impacts; and
- o surface and seabed drifters, to indicate long-term (non-tidal) effluent transport.

Phase II Physical Oceanographic Sampling Design

The Phase II field program involved the detailed collection of physical oceanographic data, and was performed in the principal study area for a period of six months, from mid-March through August, 1987. The program was divided into two parts: winter/spring sampling from mid-March to mid-May; and summer sampling from mid-May through August. In anticipation of the "Mass Bay" Program, MWRA is continuing the deployment of current meters at four locations through March of 1988.

The Phase II field program was designed for three specific purposes, over and above the overall program goals:

1. to directly assess circulation and existing water quality conditions within the study area;
2. to provide data for initial dilution analyses at potential diffuser sites; and
3. to calibrate circulation and mass transport models of the study area.

Phase II Physical Oceanographic Field Data Collection

The Phase II data collection efforts consisted of the following elements:

- o tide level recorders for analysis of tidal forcing and residual boundary tilts to serve as input to the hydrodynamic model, TEA;

- o recording current meters to assess instantaneous and residual circulation, and to calibrate the hydrodynamic model, TEA;
- o continuous conductivity-temperature-dissolved oxygen (CTDO) measurements to assess time-varying stratification and to identify the magnitude and frequency of dissolved oxygen depressions;
- o vertical CTDO profiles to assess instantaneous stratification and profiles of dissolved oxygen;
- o drogue tracking studies to assess long-term (4-day) water movement;
- o climatological data to assess relationships between wind and Bay circulation; and
- o a chemical tracer study to assess large-scale mixing and calibrate the mass transport model, ELA.

Figure 6.3.2-1 also shows the Phase II field data collecton sampling stations.

6.3.3 CHEMICAL OCEANOGRAPHIC SAMPLING PROGRAM

The chemical oceanographic sampling program consisted of three types of data collection conducted by three separate research units. The type of samples collected included physical parameters such as DO, temperature, and pH, and chemical parameters such as metals and organics, and nutrients. Battelle Ocean Sciences (BOS) took physical measurements and collected samples for analysis of metals and organic compounds. Using different techniques, the New England Aquarium (NEA) also sampled for metals and organic compounds. Dr. Ted Loder of the University of New Hampshire (UNH) sampled for nutrients. The chemical oceanography program is described in detail in Appendix B.

Sampling Design

The chemical oceanography program was designed to provide water quality data to characterize the existing marine environment, and to provide basic information necessary to evaluate the impacts of the recommended plan.

BOS performed initial sampling to provide representative water quality data from the Broad Sound area and from a distinct offshore site in Massachusetts Bay. The data were used primarily in conjunction with physical oceanographic modeling efforts. After completion of the initial sampling cruise, other studies were added in response to comments from various organizations and individuals. These studies included an evaluation of the bioaccumulation potential of the existing wastewater and were conducted by the NEA. As part of the bioaccumulation program, water column measurements of metals and organics were necessary and thus sampling for metals and organic compounds became part of the NEA program. The number of stations and the frequency of sampling were expanded to meet the needs of the bioaccumulation

study. Also, water column measurements were reassigned to UNH as part of the nutrient and primary productivity study, and the number of stations and frequency of sampling were again increased.

Field Data Collection

Physical Water Quality

During April of 1987, BOS performed sampling at stations in Broad Sound and in Outer Massachusetts Bay, as shown in Figure 6.3.3-1. Physical water column parameters were measured in conjunction with samples collected for trace metals and organics in seawater. Temperature, pH, salinity, sigma-t, turbidity, and DO as functions of depth were measured and recorded.

Also, biweekly from mid-July through mid-September, 1987, UNH determined vertical profiles of temperature, salinity, DO, irradiance, and Secchi disk depths at four stations as shown in Figure 6.3.3-1.

Additionally, as described in Section 6.4.1, a portion of the physical oceanography field program included deployment of CTDO meters. CTDO transects through Broad Sound and Nantasket Bight were also conducted.

Water Column Metals and Organics

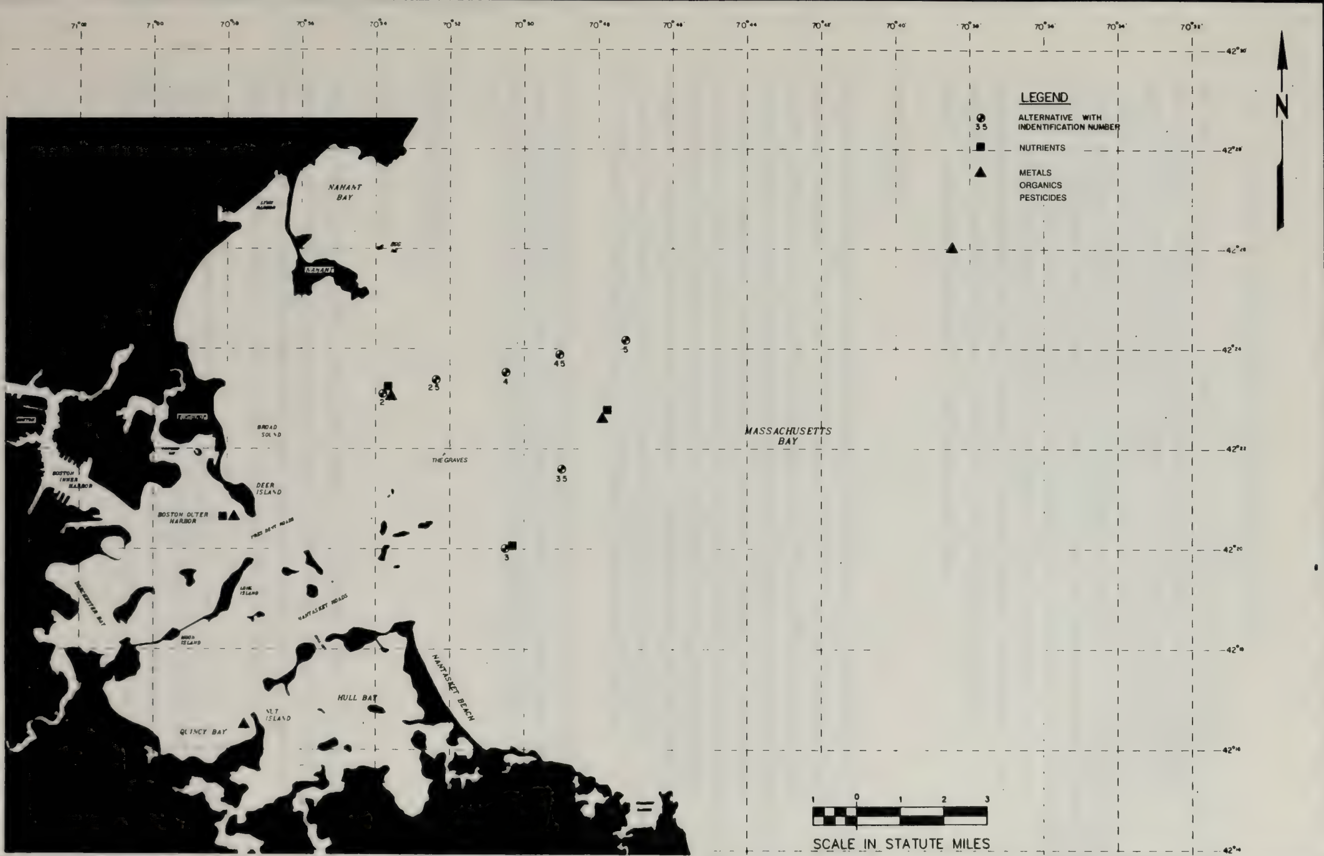
During the April, 1987 cruise, BOS collected discrete water samples in triplicate from stations in Broad Sound and Outer Massachusetts Bay. Samples were taken at each of three depths for analysis of dissolved and particulate fractions of nine metals (cadmium, copper, chromium, nickel, zinc, arsenic, lead, vanadium, and mercury). Duplicate (Outer Massachusetts Bay) or triplicate (Broad Sound) water samples for analysis of dissolved and particulate forms of 35 organic compounds (PAHs and PCBs) were collected at two depths.

In July and August, 1987 NEA also collected samples in Outer Massachusetts Bay and analyzed for metals, PAHs, PCBs and chlorinated pesticides.

NEA also sampled metals and organic compounds as part of their assessment of bioaccumulation potential. Water samples were collected at three stations at weekly intervals over a 60-day period for organic compound analysis. For soluble metal concentrations, samples were collected at weekly intervals at the Deer Island and Nut Island sites over the 60-day period, and biweekly at the Massachusetts Bay station. In addition, once during the study, water samples were collected at the Deer Island and Nut Island sites over one complete tidal cycle (at least 6 samples over 12 hours) and analyzed for metals.

Nutrients

In conjunction with studies on primary productivity and eutrophication potential, samples were collected to determine existing nutrient concentrations. Water samples were collected biweekly at four sampling stations from mid-July through mid-September of 1987. Nutrient samples were analyzed for ammonia-N, nitrate-N, nitrite-N, orthophosphate, and silicate. An aliquot of the sample was also analyzed for salinity.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 6.3.3-1
CHEMICAL OCEANOGRAPHIC FIELD PROGRAM

6.3.4 BIOLOGICAL OCEANOGRAPHIC SAMPLING PROGRAM

The marine ecology program consisted of a number of distinct field investigations in support of the outfall siting. BOS had primary responsibility for the benthic, fish, and epibenthic shellfish sampling and for benthic reconnaissance surveys. Related marine studies were conducted by other institutions/parties, including: histopathology, body bioburden, and bioaccumulation studies by the NEA; remote ecological monitoring of the seafloor (REMOTS) by Science Applications International Corporation (SAIC); and nutrients and primary productivity studies by Dr. Ted Loder (UNH) and Dr. Ted Smayda of the University of Rhode Island (URI). The objectives of all these studies were: to provide baseline, site-specific ecological data; to characterize the existing marine environment; to evaluate candidate outfall sites as part of the outfall site selection effort; and to provide the basic information necessary for the detailed environmental assessment for the recommended plan.

Sampling Design

BOS conducted a benthic reconnaissance survey using a remotely operated vehicle (ROV) in November/December, 1986, and SAIC conducted a REMOTS survey in January/February, 1987. Results of these surveys were used to select sampling stations for the benthic sampling program. Sampling stations at seven candidate sites were chosen. Assumptions were made as to the number of stations, the parameters, and the number of replicates to be sampled. Results of the initial ROV and REMOTS surveys indicated that the bottom sediments of Massachusetts Bay were heterogeneous. Consequently, three stations per outfall site were identified for benthic sampling. Different types of samples were taken at different stations, and the sampling schedules varied, depending on the parameters being studied, as described below. Figure 6.3.4-1 shows the sampling locations for the biological oceanographic program.

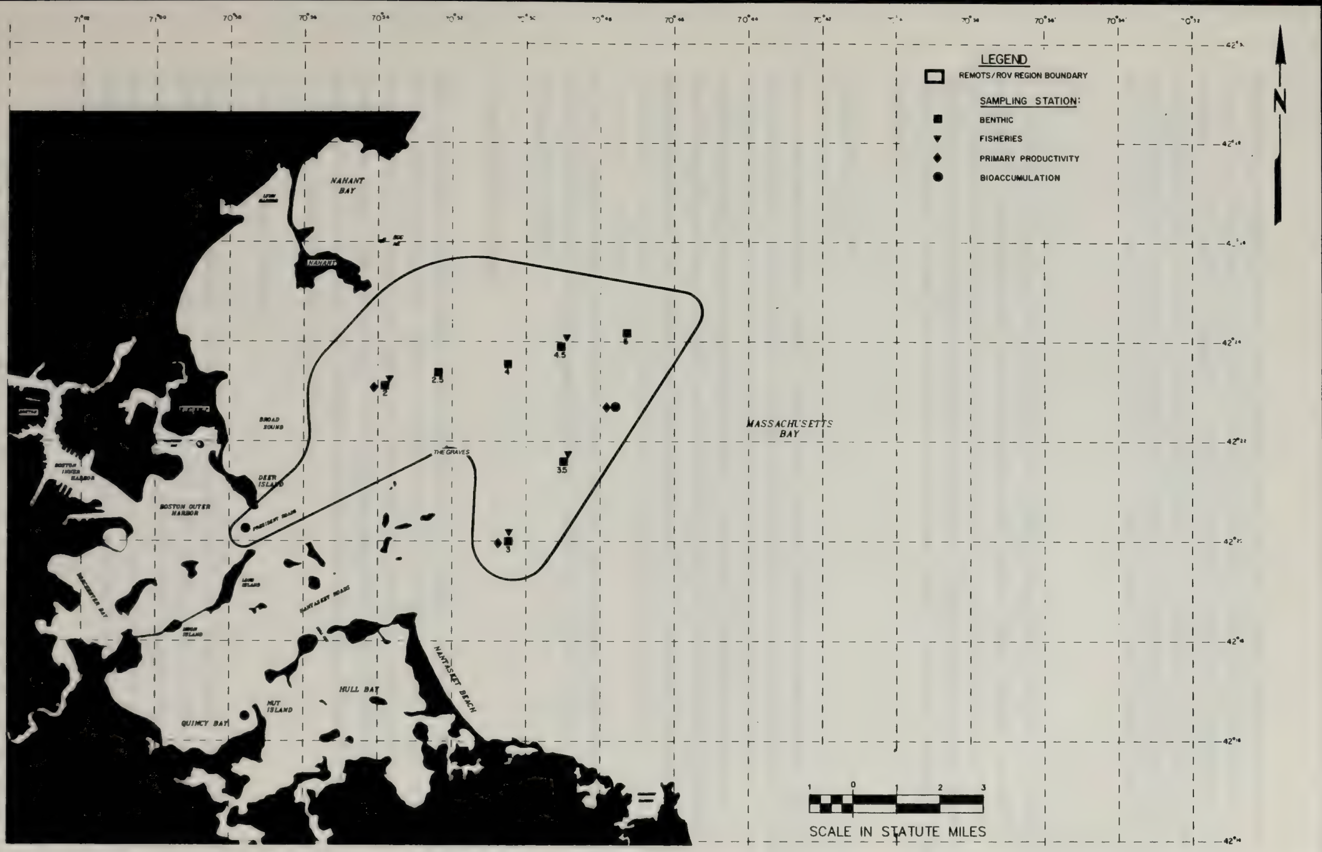
Other biological studies were added to the biological oceanographic program throughout the course of the facilities plan. Based on comments by technical reviewers, bioaccumulation, histopathology, and body burden studies, as well as an assessment of primary productivity were added.

Field Data Collection

First ROV Survey

BOS conducted the first ROV survey in November and December, 1986. The purpose of the benthic reconnaissance cruise was to characterize the benthic environment in several regions of Massachusetts Bay, providing information on the habitats found in the study area for use in selection of station locations for the benthic biology and chemistry programs.

Twenty-seven sites located in Massachusetts Bay, in depths between 42 and 120 feet, were studied during the cruise. The different types of samples gathered on this reconnaissance cruise included: video tapes of the bottom at each site; Van Veen grab samples at 17 sites for sediment analysis; Van Veen grab samples at 18 sites for biological analysis; observations by



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 6.3.4-1
BIOLOGICAL OCEANOGRAPHIC FIELD PROGRAM

scuba divers at 8 sites, 35-mm photographs at 8 sites; and verification specimen collections at 8 sites. From these sample types, information was generated characterizing the bottom topography and its relative homogeneity, sediment grain sizes, the number of benthic species, and the habitat types and energy regimes of sampling sites. The epifaunal invertebrates, fish, and microalgae were enumerated and identified by species or lowest practicable taxon. Samples of the hard bottom were brought to the surface for identification of small sessile organisms.

Second ROV Survey

A second ROV survey was conducted during July, 1987 to determine the degree of variability along each of the seven benthic sampling transects and to assess fishery resources at each site. This survey allowed BOS to characterize in detail five sites along each transect and to determine the amount of heterogeneity along each transect. Fishery resources along these transects were also assessed, and were used to supplement results of the fishery program being conducted.

First REMOTS Survey

SAIC conducted an initial REMOTS survey at 42 stations throughout Massachusetts Bay in February and March, 1987. The two major objectives of the REMOTS survey were to provide a broad characterization of the seafloor in the study area in terms of physical and biological conditions, and to provide reconnaissance mapping information to be utilized in selecting benthic sampling stations. Features such as sediment grain size, sediment surface boundary roughness, erosional and depositional characteristics, depth of the apparent redox potential discontinuity, and the infaunal successional stages were measured and mapped.

REMOTS measurements of all physical parameters and some biological parameters were measured directly from black and white film negatives using a video digitizer and computer image-analyzer system.

Second REMOTS Survey

SAIC performed a second, follow-up REMOTS survey in August, 1987 at 70 stations to support the marine ecology investigations related to the outfall siting. The specific objectives of the second REMOTS survey were to provide a more precise delineation of the transitional zones between the types of benthic habitats; a more accurate characterization of potential outfall sites; and a comparison with initial REMOTS results to determine the potential for, and extent of, sediment movement within the study area.

Fish and Epibenthic Shellfish

Field surveys were conducted in the early spring, late spring, and late summer of 1987 to provide more site-specific data on fishery potential near candidate outfall sites, and to assess, on a gross scale, the general health of the fishery. Fish and epibenthic shellfish (crabs, lobsters, etc.) were sampled at three stations during the first cruise and at six stations during the second and third cruises. Sampling equipment included otter trawls and gillnets.

The catch from each tow was identified, measured, and enumerated by taxon. During the measuring process, all fish collected were examined for gross abnormalities such as fin rot or visible tumors. The livers of winter flounder were removed and turned over to NEA for histopathological examination as described below.

Benthic Biology

The purpose of the benthic biology program was to evaluate the spatial and temporal patterns of the benthic community. The results provided an assessment of the current health of the study area and information by which impact assessments could be conducted.

Seven transects with three stations each were targeted for benthic sampling; five of the stations were soft-bottom and two of the stations were hard-bottom.

Soft-Bottom Sampling. Soft-bottom benthic sampling cruises were conducted in March-April, June, and August, 1987. A total of 90 soft-bottom biological samples (15 stations, 6 replicates each) were collected on each cruise using a $0.04m^2$ Van Veen grab sampler. Each sample was sorted to major faunal components prior to taxonomic identification and enumeration. Faunal identifications were performed by taxonomists experienced with the individual faunal groups.

Hard-Bottom Sampling. Hard-bottom sampling occurred during April-May, July, and August, 1987, and consisted of still-photography and suction-collected samples. Divers sampled three stations on each of the two hard-bottom transects (six stations total) and collected suction samples from the rocky transects using an underwater vacuum apparatus. The samples were then sorted and identified to the lowest possible taxon.

Random photographs of hard-bottom stations were taken during the first survey. More than 50 $0.25\text{-}m^2$ quadrat photographs were taken along transect lines at 2-m intervals, and the most representative station per transect was selected for fixed-quadrat sampling. These fixed quadrats were sampled throughout the three sampling periods.

Benthic Chemistry

The purpose of the benthic chemistry program was to characterize the sediments near the candidate outfall sites and to assist in identifying the potential impacts of construction and operation of the outfall. From each of the five soft-bottom benthic sites, 45 sediment samples were collected for the analyses of metals and organics, sediment grain size and carbon:hydrogen:nitrogen (CHN) ratios. Sediment samples were collected during the same March-April, June and August, 1987 cruises as the soft-bottom benthic biology sampling.

A $0.1\text{-}m^2$ Teflon-coated Van Veen grab was used to obtain sediment samples for chemical, grain-size, and CHN analyses. Chemical analyses included total and individual polynuclear aromatic hydrocarbons (PAHs), total PCBs, and nine trace metals (cadmium, copper, chromium, nickel, arsenic, lead, vanadium, mercury, and zinc).

Primary Productivity

The purpose of the primary productivity program study was twofold: to relate observed trends and regional differences in the phytoplankton community structure and abundance to existing physical and chemical environmental conditions, and to investigate potential impacts of a marine wastewater discharge on the existing plankton community.

To obtain an overall view of the study area, the program involved the collection of water samples at three locations in Massachusetts Bay and one in Boston Harbor, as shown in Figure 6.3.4-1. The Massachusetts Bay water samples were analyzed for identification of the following: numerical abundance of phytoplankton species; biomass as determined by chlorophyll; primary productivity; carbon growth rates; and potential impact as measured through nutrient spike experiments.

Water samples were collected biweekly at three sampling stations from mid-July through mid-September, 1987. Locations were selected to characterize alternative zones in Massachusetts Bay.

Histopathology of Body Bioburden

In response to comments from various individuals and organizations, studies were initiated to assess the current health of commercially important fish species (winter flounder) by histopathological examinations and body bioburden analyses for metals and organic contaminants.

Winter flounder were collected during the July, 1987 sampling cruise from three fish sampling stations. The flounder were partially dissected and portions of their livers were removed for histopathological analyses, to determine the presence of liver lesions, tumors, and other histopathological abnormalities. Incidence of disease was compared to information from other studies to assess the relative health of the fish in this portion of Massachusetts Bay. Edible tissue was analyzed for metals (Cd, Cr, Cu, Hg, Ni, Pb, and Zn) and organic contaminants (PCBs, PAHs, and chlorinated pesticides).

Bioaccumulation

A bioaccumulation study was conducted on the effluent from Deer Island and Nut Island. The purpose of the study was to assess the bioaccumulation potential of current discharge as a means of predicting bioaccumulation of the future discharge.

Mussels were deployed within the mixing zone at both the Nut Island and Deer Island facilities, and at an offshore site as shown in Figure 6.3.4-1. The accumulation of metals and organics in marine mussels (Mytilus edulis), which were transplanted to the selected sites from clean sites, was measured.

Mussels collected from a clean site were individually analyzed for time-zero concentrations of metals (Cd, Cr, Cu, Hg, Ni, Zn, and Pb) and organics (PCBs, PAHs, chlorinated pesticides, and lipids). The bioaccumulation for organics was determined after a 30-day deployment. Metal accumulation was measured after 60 days.

6.4 RESULTS OF FIELD INVESTIGATIONS

This section of the document presents, in summary fashion, the results of field studies and data interpretations. The purpose of this section is to describe current knowledge of Massachusetts Bay in terms of circulation patterns and the effects of various naturally occurring events, the chemical nature of the water column, and the general biological makeup of the study area.

The results are presented in three categories: physical oceanography, chemical oceanography, and biological oceanography. Each category is subdivided into two sections: summary of results, and implications for outfall siting.

For detailed discussions of these topics, the reader should refer to Appendix A, Physical Oceanographic Investigations, and Appendix B, Chemical and Biological Oceanography.

6.4.1 PHYSICAL OCEANOGRAPHY

The physical oceanographic program involved deployment of current meters and CTDO meters, conducting CTDO transects and drogue studies, and assessments of the relationships between current movement and climatological events. The program provided a significant amount of useful information for evaluating the candidate outfall locations. For example, data from current meters and drogue studies revealed that there are major differences between inshore sites, which are strongly affected by tidal currents, and offshore sites, which are affected both by the tide and other long-term transport patterns. This long-term transport phenomenon has far-reaching effects on outfall evaluation, since discharges in this region will have a greater tendency to be carried offshore away from sensitive coastal resources.

Summary of Phase I Field Program

Data collected during the Phase I survey in 1986 and previous surveys provide a preliminary understanding of the physical oceanography of the study area. The following findings can be drawn from an analysis of all the existing data:

- Circulation patterns are strongly tidal, with tidal excursion distances ranging from 2-3 km offshore to about 5 km in the vicinity of President Roads. However, wind can cause significant movement, particularly in the upper water column. Since President Roads is a constriction, both laterally and vertically, there is an acceleration in its vicinity resulting in swifter currents and increased excursions entering Boston Harbor. Drogue studies indicated that material released beyond a point somewhat west of Site 2 would not enter Boston Harbor on the first flood tide following discharge.

- Drogue studies indicate the possibility of current variations with depth, particularly to the south of the Outer Harbor Islands (Site 3).

- DO measurements suggest a nutrient enrichment of waters, with July values showing supersaturation near the surface and lower values near the bottom. In general, readings were on the order of 7-8 mg/l, with the exception of a few samples within Boston Harbor and near the President Roads sludge discharge.

The available data from Phase II permit an initial understanding of the ocean mechanics of the study area and an assessment of the possible impacts caused by discharging wastewater. It also provides a useful basis for some preliminary analyses, and for designing the much more comprehensive Phase II data collection program.

Summary of the Phase II Field Program

- The results of the physical oceanographic data collection program confirm the hypothesis that three distinct flow regimes occur in the study area. Onshore, the flows through President Roads and Nantasket Roads have the strongest velocities, but are localized. This is also an area of intense vertical mixing, caused by the narrow and shallow openings, as can be seen from vertical constituent profiles.

- In Broad Sound and Nantasket Bight, the flows are tidally dominated, and restricted due to the semi-enclosing nature of coastal geometry from Nahant to Nantasket. Vertical stratification occurs during the late spring/summer warming trend, as well as during large freshwater events, such as the major rainfall/snowmelt runoff in April, 1987. The formation of the pycnocline alters the residual flow directions, even over a period of about one week, and somewhat decouples the upper and lower water columns. The upper column then responds to both tides and wind. The lower column responds to the tide and to long-term circulation features in Massachusetts Bay, if they are from the direction not blocked by coastal geometry.

- Further offshore, the "sheltering" effect of Nahant and Nantasket rapidly decreases, and the waters of Massachusetts Bay proper are much more energetic. A tidal component can be seen in the offshore region, but residual variations at the 6-10 day meteorological time scales are quite strong. During certain periods, for approximately a week, evidence of a shear zone to the east of the Harbor can sometimes be seen. Currents to the north during these periods are often consistent with an anticyclonic (clockwise) gyre, which moves waters past Nahant toward Gloucester. To the south of this area, currents are consistent with the formation of a cyclonic gyre, with water being transported to the south, past Nantasket Beach, toward Cape Cod Bay. At other times, all offshore stations show a net counterclockwise movement.

- The transects of temperature, salinity, and density show an onshore freshwater mass caused by freshwater runoff, and an offshore freshwater mass probably caused by the Merrimack River plume. The importance of these density features is that the gradients produced can drive long-term residual circulation. In terms of vertical density stratification, the slow buildup of thermal stratification can be quickly enhanced during the spring by freshwater inputs or plumes. When these plumes subside or become mixed with ambient seawater, thermal stratification is well under way, reaching its peak in August.

- The degree of stratification varies throughout the study area. At President Roads, the system is well mixed, particularly within the shallow Outer Harbor. Proceeding offshore, the maximum depth to the pycnocline increases, and, at Site 5, can reach a maximum of 23 m in 35 m of water. The depth of the pycnocline strongly affects both initial dilution and the height to which the effluent plume will rise.

Implications For Outfall Siting

The data analyses indicate a complex circulation structure. The major process affecting short-term transport is the tidal flow: flood and ebb. These processes affect the degree of initial mixing within the mixing zone, but also the immediate transport of the wastewater plume within the tidal excursion zone. Tidal excursions are on the order of 1-2 km nearshore and 2-3 km offshore (except for the much larger excursions in the vicinity of President Roads and Nantasket Roads), and all of the candidate outfall sites are at least this far from land. Furthermore, between 60-90 percent of the observed variance in the current is in the semi-diurnal tides, which implies that non-tidal processes, such as wind, are relatively minor in their effect on instantaneous transport. Non-tidal forcing (processes such as wind, stratification, and shoreline geometry) can affect transport at intervals of one day or more.

Some of the findings that are important for outfall evaluations are:

- The ocean becomes much more energetic (residual time scales of 6-10 days) with increasing distance offshore. The data show that although the inlets to the Outer Harbor are energetic, Broad Sound and Nantasket Bight are more quiescent. Not until beyond the Outer Harbor Islands does the energy dramatically increase, indicating the blocking effect of coastal geometry in the nearshore areas to steady, low frequency currents in Massachusetts Bay. The implication of this is that mixing processes are much stronger beyond Site 4.

- The blocking effect of coastal geometry may cause net residual transport toward the local shoreline, as observed in drogue data. This is because the effect of steady, low frequency currents in Massachusetts Bay may be felt from the exposed direction, although the coastline may block the opposite current. For example, data near Site 3 show onshore movements toward Nantasket Beach during a north-to-south current condition, but little movement during the south-to-north current condition. The net effect is residual transport toward Nantasket. A similar process could happen in Broad Sound with respect to Nahant. This implies that onshore sites may be more quiescent than offshore sites, and have residual flow toward land.

- There is evidence of recirculation of features in Broad Sound and Nantasket Bight. The net effect is a recirculation cell. The implications are that nearshore discharges can be more readily drawn back into the Harbor on flood tide due to the recirculation cell.

- Seasonal stratification follows the classical model of vertical homogeneity in the winter, transforming to a stratified two-layered system. The stratification is most intense in August. The onset of stratification can be fairly rapid with freshwater runoff in the

spring enhancing solar heating of the water surface. The stratification breaks down from time to time due to storm events, but re-establishes itself fairly rapidly over a period of about one week. This breaking down of the seasonal pycnocline lends further support to the use of a two-dimensional model of Massachusetts Bay. The models are also discussed in Appendix A. During summer months, effluent discharged at offshore sites may remain trapped for some time beneath the seasonal pycnocline, whereas discharges from onshore sites may surface more frequently.

- Wind can be a significant factor driving circulation, particularly in the upper layer when stratification is present, provided the wind is not strong enough to break down the stratification. An examination of drogue data, coupled with current data, shows that there is a greater potential for the upper layer to move toward the nearest shoreline, rather than away from it. This emphasizes the fact that within Broad Sound and Nantasket Bight coastal geometry blocking may have significant impacts on transport patterns.

- Sediment resuspension is possible at all depths. However, data (Butman 1977 and 1987) indicate that the resuspension potential diminishes with increasing water depth (and to some extent with distance offshore). This implies that resuspension of contaminants and the resultant impacts are minimized at offshore sites.

These results indicate a complex circulation pattern in the study area. Circulation patterns are caused by an interaction of tides, wind, and low-frequency currents in Massachusetts Bay, and indicate a generally more energetic system (and thus increased transport and mixing) with distance offshore. The implications of these results on outfall siting are discussed in greater detail in Section 7 of this Volume.

6.4.2 CHEMICAL OCEANOGRAPHY

Although water quality data alone have only a small impact on outfall siting, the data is valuable in conducting the analyses required to assess each site based on the outfall criteria. Coupled with knowledge of the physical characteristics of the region, the chemical oceanography data provide significant information for siting and impact assessment. For instance, the existing concentration of metals and organics in the water column are required as input to the assessment of each site's ability to meet EPA Water Quality Criteria.

Summary of Chemical Oceanographic Field Program

Data collected as part of the chemical oceanography field program, coupled with water quality data collected under the physical oceanography program, provide a cetain degree of understanding of the Massachusetts Bay system. The following best describes current knowledge of the chemical oceanography of Massachusetts Bay.

A detailed summary of the program results are also contained in Appendix B. A brief summary of the water quality, water chemistry, and nutrients sampling results are provided herein.

- The hydrographic data collected in this study are consistent with available information on Massachusetts Bay. For example, studies have shown an annual cycle of thermal heating leading to stratification of the water column, such as the one that occurred during the MWRA study period. However, a combination of saturated ground conditions and heavy spring rains in April, 1987 contributed to a 100-year freshwater inflow event into the Massachusetts Bay and Gulf of Maine region (Dr. B. Gardner, Univ. Mass.). This high influx of fresh water enhanced the normal seasonal stratification of the water column.

- The concentration of oxygen in the surface waters was lower than in the deeper water for the early summer. The bottom water DO concentration decreased toward the end of the summer, due to natural decomposition of benthic organic matter. However, there were no indications of any significant oxygen depletion at any of the stations. No significant changes in oxidation-reduction (redox) potential as a function of depth were observed in the water column at any of the stations, indicating that the water column was well oxygenated.

- The total suspended solids (TSS) concentration range observed in Broad Sound is typical of coastal waters away from the immediate influence of river sources, although somewhat higher than observed in previous studies. Furthermore, the distribution of TSS undoubtedly varies with the seasons and with the hydrographic and biological status of the system.

- Salinity throughout the area ranged from around 30.5 - 31.4 parts per thousand (ppt) in surface waters, to about 31.5 - 31.8 ppt in bottom waters. Salinity in the surface waters varied by a few tenths of a ppt during the sampling period. This variation probably reflects water masses of slightly different salinities moving through the sampling area. Salinity was lower at the surface and higher in the deeper water, as is normal for coastal waters.

- The pH values are affected by the carbon dioxide-carbonate system in seawater, which in turn is affected by primary productivity. The ranges observed were normal for surface waters, with values near the surface falling mostly in the pH range of 8.0 - 8.1. The pH level was variable in the surface waters at all stations. Deeper waters generally have pH values lower than the surface values, because respiration releases carbon dioxide within the water column. The pH in the deeper waters decreased from about 8.0 to 7.7 during the sampling period.

- Remobilization of metals from particles transported to depth from the surface layer may be occurring in this water column in much the same way as observed in more oceanic systems. In Broad Sound, the high metal concentrations in the water mass near the sediment/water interface show clear indications of signficant sediment resuspension in this area. The concurrent increase in most of the dissolved metals studied also suggests that the metals re-enter the water column as dissolved metals (remobilized from sediments) or from the resuspended sediments. This water layer may also be influenced by sediment sources located upstream, or possibly in Boston Harbor (Gardner and Wallace, 1986).

- o The concentrations of both dissolved and particulate PAHs were in the range generally expected for this type of coastal marine environment (Boehm et al., 1983; DeLappe et al., 1983; Boehm, 1983).

- o Nitrate and nitrite levels were very low in the surface waters, except at inner Harbor sites. These levels were relatively low in the bottom waters throughout the sampling period. This suggests that removal had occurred pretty much throughout the water column by the middle of the summer. Increases in the bottom water concentrations suggest that regeneration of nitrate and nitrite occurred during the late summer. Nitrite concentrations are generally quite low in surface waters relative to nitrate or ammonium concentrations, since nitrite is a chemical intermediate produced during nitrogen transformations (nitrification, denitrification, and nitrate reduction). The concentration of nitrite does indicate, however, that nitrogen transformations are occurring. Ammonium is the most reduced form of nitrogen. It is generally the preferred form for nutrient uptake by phytoplankton, and as such, is rapidly recycled in the water column. Nutrient levels in Boston Harbor and Broad Sound had consistently much higher values than in Nantasket Bight and Outer Massachusetts Bay.

- o The Redfield ratio of nitrogen to phosphorus for coastal systems is expected to be between 15 and 16:1 N:P. In general, the N:P ratio at inshore stations is between 1 and 7 and somewhat higher in the offshore area.

The data suggest that this region is strongly influenced by several sources whose relative magnitudes and degrees of influence are not clearly established. The system appears to have a major recycling component in the sediments and possibly in the water column; this component will strongly influence the fate and transport of contaminants introduced into Massachusetts Bay.

<u>Implications for Outfall Siting</u>

The chemical oceanography studies, by themselves, do not have a great effect on outfall siting, but they do provide some necessary information to conduct the modeling of the future discharge (see Appendix A). However, observations taken from this program, combined with the results of other programs, can lead to significant conclusions about siting. The following are general observations from the chemical oceanography program:

- o The ambient ocean water has higher existing concentrations of arsenic and PCBs than the EPA Water Quality Criteria for these constituents. Although MWRA effluent contains these constituents in very small amounts, discharge of any amounts would cause a violation of EPA criteria. Thus, this violation would occur regardless of outfall location. The implication is that for arsenic and PCBs, the EPA Water Quality Criteria are not considered site-determinative.

- o In this study it has been shown that resuspension and remobilization of metals (and possibly organics) from the sediments occur. Based on the results of the physical oceanography program, the likelihood of reuspension decreases with increasing depth (or distance offshore). Assuming that resuspension of contaminants is undesirable, offshore outfall locations would provide greater protection from resuspension, and would therefore minimize remobilization of contaminants into the water column.

- o The fact that both the surface and bottom waters are currently well-oxygenated indicates that Masachusetts Bay has a great ability to assimilate wastes from the existing discharges without detriment to marine biota. This implies that a secondary effluent discharge to Massachusetts Bay probably will not cause DO depressions leading to significant short-term disruption to the marine biota.

- o The inshore regions of Massachusetts Bay are affected by coastal water masses, as indicated by the higher nutrient levels at the inshore areas. This implies that nearshore nutrient loads are well-diluted by the time they reach the offshore sites. The offshore sites provide greater dispersion, thus discharges to these areas will have smaller impacts on primary productivity since nutrient levels would be lower. Offshore sites will provide a greater safety factor in terms of minimizing nuisance algal blooms.

6.4.3 BIOLOGICAL OCEANOGRAPHY

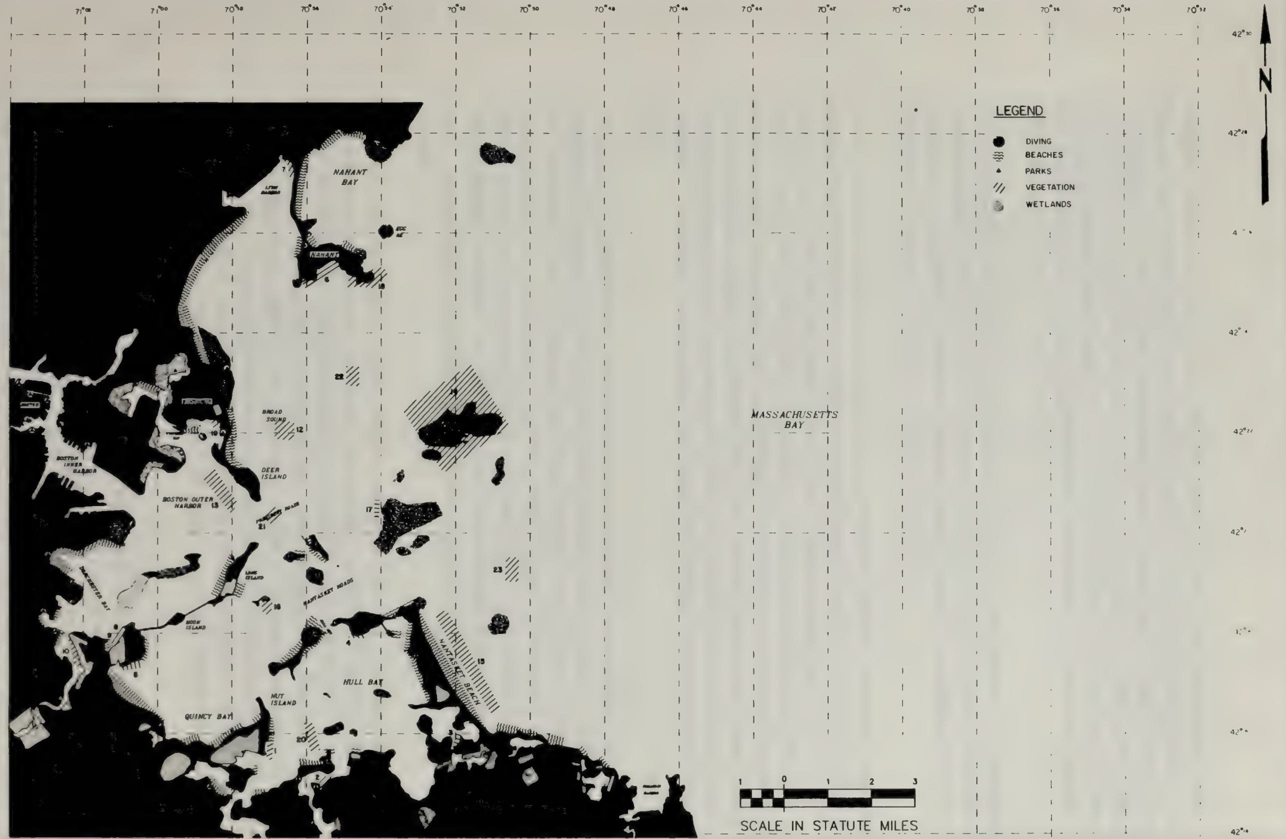
The biological oceanography program consisted of the following: a resource mapping effort to define, on a broad scale, the marine resources of the region; a series of benthic reconnaissance surveys to identify general topographic conditions and, where possible, fisheries resources; benthic biological and chemical sampling to evaluate the health of the benthic community; fish and shellfish sampling to complement DMF studies by providing more site-specific information on fisheries resources; and primary productivity studies to evaluate the current plankton community structure and abundance.

The purpose of the biological program is to provide a link between the knowledge of available dilution and circulation patterns of Massachusetts Bay and the potential impacts on marine resources from the proposed MWRA discharge. An understanding of the transport of pollutants, the existing water quality, and the type and abundance of marine species, will lead to an assessment of the ability of a particular site, and Massachusetts Bay in general, to assimilate, without adverse impacts, the MWRA wastewater discharge.

Summary of Results of the Biological Oceanography Program

Shown below are the results of the biological oceanography program:

- o There are more than 100 recreational beaches and parks in Massachusetts Bay, extending from Lynn to Scituate. These facilities are owned and operated by a variety of towns, cities, state and federal agencies, and private parties. Use of the beaches and Boston Harbor/Massachusetts Bay by weekend and summer boating enthusiasts is extensive. Recreational diving is also extensive, since there are several shipwrecks and other resources available. Recreational resources are shown in Figure 6.4.3-1.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 6.4.3-1
GENERAL MASSACHUSETTS BAY RECREATIONAL RESOURCES

- Shellfish constitute one of the major fisheries resources along the Massachusetts coast. There are more than 5,000 acres of shellfish beds in the study area. The soft-shell clam (Mya arenaria), is the principal commercial species. Some local harvesting of the edible mussel (Mytilus edulis), the hard clam (Mercenaria mercenaria), and sea clams (Spisula solidissima) occurs within Boston Harbor. Scallops were seen at all stations, but were most abundant in rocky habitats. Unfortunately, approximately 2,300 acres of shellfish beds have been closed for many years due to pollution.

- The commercial lobster fishery is the most valuable fishery economically. Lobstering is intense around the Harbor Islands, in western Broad Sound and in western Nantasket Bight. Because of the migratory habits of the species, lobster fishing is concentrated inside the Harbor in the summer and outside the Harbor in the fall.

- Winter flounder and herring are the principal commercial finfish in the study area. Winter flounder were observed at most stations, but the highest numbers were found at Sites 2, 2.5, 3, and 4. Very few fish were found at Site 5; this area seems to be at the outer extent of commercial finfish dragging activities. The largest herring catch was in the vicinity of Site 2 followed by Site 3, indicating that these sites are along the migratory route of anadromous fish. Regulations call for the periodic closure of all waters along the Massachusetts coastline to commercial fishing in order to protect spawning winter flounder. The closed area extends to about one mile offshore from February 1 through April 30th.

- The benthic environment of Massachusetts Bay is extremely heterogeneous, being composed of sediments that ranged from 90 percent silt/clay content to rocky habitats consisting of large boulders. Areas of relatively high kinetic energy, reflecting non-depositional areas appear to exist along the sides of the Boston North Shipping Channel and at the offshore Stations 5 and 3.5. A major low kinetic area, termed the "mud patch" was found to exist south-southeast of Nahant. In this area, there was an accumulation of fine-grained organic mud. Another potential depositional area occurs at Station 2.5, based on sediment grain size data.

- Redox potential discontinuity (RPD) depths equal to or less than 3 cm have either experienced recent physical disturbance or are likely candidates for having high sediment oxygen demand. Four areas were identified with RPD depths equal to 3 cm or less; south of Deer Island is characterized by sediments that have extremely high sediment oxygen demand, where methane gas is actively being produced; south of Nahant and northeast of the Boston North Shipping Channel may also be experiencing increased deposition of labile organic detritus as a result of the effluent discharge at Deer Island. Other areas of comparatively shallow RPD depths exist in the easternmost and southeasternmost sections of the study area.

- There is strong evidence for the maintenance of a small- to medium-sized depositional area in and around Site 2.5, which is subjected to sediment resuspension and sediment transport in a northern direction along, but not through, the watermass boundary. It thus appears

that PAH compounds and metals delivered to the nearshore zone at the mouth of Boston Harbor may be restricted in their further transport out into Massachusetts Bay, and may remain trapped along the coast by this circulation pattern. It is also possible that sedimentary metals and PAH compounds are being trapped by this circulation pattern and held in the vicinity of Sites 2 and 2.5, and move only in response to strong tidal events or storms.

- The benthic epifaunal and infaunal communities are those expected for this region. The composition of the benthic community appears to indicate unstressed conditions. With respect to the biological communities present in the study area, the heterogeneity of the habitats resulted in differences in species composition and abundance among stations within transects. Differences among transects tended to be greater than within transects. The motile and attached epifauna that occurred along the seven transects surveyed were similar to those described from other communities at similar depths in the Gulf of Maine (Witman, 1985; Sebens, 1986).

  The data suggest that the study area is seasonally homogeneous, and that concentrations of metals in this region of Massachusetts Bay are generally low and not indicative of significant accumulation of metals from nearby sources. Metal (Cd, Cr, Cu, Ni, As; Zn, Hg, V, and Pb) concentrations in the study area were much lower than concentrations reported for fine-grained sediments of Boston Harbor.

- Data suggest that sediments in the north and west regions of the study site were accumulating metals. Accumulation of metals was influenced by grain-size characteristics and organic carbon content of the sediment. Observed distributions of metals and PAHs are believed to be the result of localized transport of sediments within the study area, as a result of bottom currents. The highest concentrations of PAHs and metals were found at Site 2.5. The data set suggests that metals and PAHs were accumulating in the sediments at Sites 2.5 and 4. There were indications of a general decrease in sediment metal concentrations in the offshore direction.

- The mean light transmission properties, depth of the euphotic zone, and proportion of the total water column represented by the euphotic zone, were greatest at offshore sites and decreased towards shore.

- Nutrient concentrations were generally highest in Broad Sound and lowest in the eastern section of Outer Massachusetts Bay. There were four conspicuous surges or peaks of ammonia (NH_4) concentrations in Broad Sound. These surges accompanied the incursion of a colder water mass into the euphotic zone. These four NH_4 peaks were accompanied by similar surges in SiO_2 concentrations and were accompanied twice by increases in nitrate-nitrite (NO_3 + NO_2).

- Mean water column concentrations of total chlorophyll were greatest at the inner Harbor station and decreased with increased distance from shore.

- Nutrient spike experiments carried out in July and September indicate that enrichment with NH_4, PO_4, and SiO_2 in various combinations stimulated carbon production rates, chlorophyll

biomass yield, and species growth rates. Certain nutrient combinations may have suppressed individual species growth rates. Enrichment with various N+P+Si combinations tended to stimulate growth activity more than enrichment with various N+P combinations.

- Enrichment did not trigger blooms of nuisance species or algal groups during the 48-hour experiments, and total community structure remained intact.

- Considerably greater biomass and growth-rate stimulation (relative to the control) generally occurred in Outer Massachusetts Bay. However, final biomass yield in Outer Massachusetts Bay usually did not exceed that of Broad Sound.

Implications to Outfall Siting

The results of the biological oceanographic program have far-reaching implications for outfall siting. Massachusetts Bay has a wide variety of marine resources, including an extensive finfish and lobster fishery and numerous recreational beaches, parks, and underwater diving areas. Protection and enhancement of these resources is of paramount importance to MWRA.

In order to protect these resources, an understanding of physical and biological processes is critical. Transport and sedimentation patterns of the Bay dictate which marine resources will be affected by outfall siting and to what degree. Appropriate placement of the discharge, balancing protection of all resources, affords the greatest possible protection of the Bay as described below.

- Several areas within the Bay could be considered within either a short- or long-term depositional area. This implies that a discharge, even with the minimal amount of solids from secondary wastewater, should not be located in these areas in order to minimize the impacts to benthic biota.

- The nutrient levels and the primary productivity are much greater at the nearshore sites than at the offshore sites. While nutrient spiking at offshore sites caused higher rates of increase in productivity, the total biomass for the offshore areas never reached the magnitude of the inshore areas. The implication is that the offshore sites have a greater capacity to assimilate nutrients from the discharge without causing adverse impacts as indicated by blooms of nuisance algae.

- Recreational resources dot the shoreline of Massachusetts Bay from Gloucester to Cohasset. Transport patterns of the Bay indicate that offshore outfall sites will have less impact on shorelines. The implication is that the further offshore the outfall site is, the more likely the discharge will be transported away from coastline resources.

- An extensive finfish and lobster fishery occurs in the nearshore regions of the Bay, both in Broad Sound and Nantasket Bight. The implications for siting are that the discharge should be located in an area both with lower density of fisheries and, possibly, where commercial fishery is less active or not feasible. This seems to maximize the protection of this resource, which can be achieved by proper outfall siting.

6.5 SUMMARY OF FIELD INVESTIGATIONS

The overall field program in support of the outfall siting process involved physical, chemical, and biological oceanographic sampling and analyses. The program ran from March through August, 1987 (a short-term physical oceanography program was conducted in 1986), and included deployment of curent and CTDO meters; measurements of DO, pH, and salinity; metals and organics; nutrients; biological sampling for benthic and demersal biota; and benthic chemistry analyses.

The results can be summarized as shown below:

- With increasing distance offshore, Massachusetts Bay is less affected by tidal currents, more affected by long-term transport patterns, and less protected by coastal land features. This means that the discharge in the offshore area will likely be dispersed to a greater extent and would have less of an impact on marine biota.

- Certain EPA Water Quality Criteria cannot be met by the discharge at any site because of current ambient conditions. For these parameters, the Water Quality Criteria are not site-determinative. The solution to this problem lies in source control measures for all discharges to Masschusetts Bay.

- Certain areas of Massachusetts Bay, especially in the center of Broad Sound, are depositional in nature and should be avoided as a location for an outfall in order to protect the existing marine biota.

- The inshore regions of Massachusetts Bay support extensive fishery resources. An outfall located within these regions would be likely to affect the commercial availability of these fisheries by constraining the type of fishing gear that can be used. Also, while impacts of wastewater discharges on marine biota are not fully understood, it is likely that discharge of pollutants could have a deleterious effect on these resources.

- The offshore regions possess a greater potential to assimilate nutrients that have a small potential for nuisance algae blooms. Outfalls located in the nearshore region may only serve to exacerbate existing problems, while selection of offshore sites would likely help to alleviate these impacts.

Section 7

7.0 EVALUATION OF OUTFALL ALTERNATIVES

7.1 INTRODUCTION AND OVERVIEW

A key element of the Deer Island Secondary Treatment Facilities Plan (STFP) involves the selection of a location for the discharge of the treated wastewater. Over the past year, studies have been conducted to determine the optimal location for the discharge from the new Deer Island plant. These studies included investigations of the potential impacts of the construction and operation of the outfall, as well as investigations of alternative methods of constructing these facilities.

In addition, a continuing dialogue has occurred among MWRA, regulatory agencies, and various citizens' groups to define relevant criteria that can be used to select an appropriate, acceptable outfall terminus. Some 28 different criteria were selected, and were categorized into two broad areas: Environmental, and Engineering, which includes Technical, Cost, and Institutional criteria. These criteria form the framework for the analyses that led to the recommended location. Section 6 of this Volume, Existing Conditions, describes the data collected and the analyses completed to support findings concerning candidate outfall sites. Detailed information on these analyses is contained in Appendices A and B.

The purpose of this section is to present these findings and the selection of the recommended plan. The section is organized in the following manner:

Section 7.2 provides the comparison of outfall system construction techniques and the recommended outfall system plan.

Section 7.3 provides a description of the candidate outfall locations.

Section 7.4 presents a detailed discussion of each of the outfall criteria and sites.

Section 7.5 presents a summary of the comparison of outfall sites.

Section 7.6 presents the rationale for the selection of the recommended outfall site.

Two distinct issues have been the focus of detailed evaluations as part of the outfall siting studies: the method of construction of the outfall (tunnel versus dredged pipe), and the location of the terminus point. In selecting the construction method for the outfall system (outfall conduit and diffuser), two factors are considered. These factors are constructibility and costs. A detailed description of this evaluation process is given in Appendix E. Section 7.2 of this Volume is a summary of the selection process. Sections 7.3 through 7.6 describe the comparison of alternative outfall locations.

7.2 COMPARISON OF OUTFALL SYSTEMS

7.2.1 DESCRIPTION OF OUTFALL SYSTEM ALTERNATIVES

A variety of conduit types and diffuser designs have been considered in this evaluation. The conduits that have been considered include a concrete-lined rock tunnel, a single pipeline, two parallel pipelines, and a sunken tube. The tunnel alternatives can have a diffuser consisting of 20 risers or a diffuser consisting of 8 risers, with each riser terminating in a pipe diffuser. As the planning process proceeded, it was determined that an 80-riser system was required to provide adequate mixing (see Appendices A, D, and E). The comparisons herein, however, were based on a 20-riser system. It should be noted that the difference between 20 and 80 risers would not change the outcome of the selection process.

The pipeline options and sunken tube option would have a pipe diffuser. The outfall system may be a pumped-flow or a gravity-flow system. For the purpose of selecting an outfall location, a decision regarding gravity flow or pumping is irrelevant and is not discussed here. The reader is referred to Appendix E for a discussion of gravity-flow versus pumped-flow systems. The selection of a gravity-flow or pumped-flow system, and the selection of an outfall location will define the conduit size and length. The diameter of the conduit will range from a minimum of 17 ft to a maximum of 25 ft. The conduit length, including the diffuser, will range from a minimum of 25,000 ft at Site 2 to a maximum of 54,000 ft at Site 5.

For the purpose of selecting the recommended conduit and diffuser type, the differences in cost of an alternative outfall system at Site 2, with two different conduit sizes, were evaluated. The economics of a 17-ft-diameter conduit (or two 12-ft-diameter conduits for the two-pipe alternative), and a 24-ft diameter conduit (or two 17-ft-diameter conduits for the two-pipe alternative) were evaluated. A 17-ft-diameter conduit would be selected if the outfall system included a pumping station. For a gravity-flow outfall system, the conduit size would vary from 22 ft in diameter to 25 ft in diameter, depending on the outfall location. A 24-ft-diamter conduit was selected as representative of the range.

A detailed description of each alternative can be found in Appendix E.

7.2.2 EVALUATION OF OUTFALL SYSTEMS

In selecting the recommended conduit and diffuser type, a total of ten alternatives were evaluated and cost estimates were prepared. The cost estimates included a 35 percent allowance for engineering cost and contingency. For the purpose of selecting the recommended alternative, these alternatives are compared on a present-worth basis with a base year of 1990. The present-worth costs are the sum of the costs required to construct the project, presented in the form of a single initial investment. There are no operation or maintenance costs for any of the alternative conduits or diffusers.

Five alternative outfall systems (conduit and diffuser only) that would require a pumping station have been evaluated, and five alternative outfall systems that would use gravity flow have also been evaluated. The evaluation of these alternatives was based on outfall Site 2. The cost of the outfall system would vary, depending on the outfall location; however, the relative differences between the alternatives would not change.

All of the alternatives are technically feasible and each is equally constructible. Construction of all the alternatives uses proven construction techniques. All of the alternatives can be expected to provide the required design life without any planned maintenance. Construction of all of the alternatives would be in open ocean conditions and would be subject to delays due to adverse weather conditions. This risk of delays would be somewhat greater for the pipeline and sunken tube alternatives, since the scheduled duration for work on the water would be greater for these alternatives than for the tunnel alternatives.

Because the alternatives are all feasible, the final selection will be based on economics only. As indicated in Table 7.2.2-1, the alternative costing the least is the concrete-lined rock tunnel with a 20-riser diffuser. This is the recommended outfall system for either the pumping station or the gravity-flow option.

Analysis of the performance of the diffuser proceeded concurrently with the evaluation of the outfall system alternatives presented here. This analysis has resulted in an increase in the number of risers from 20, as described above, to 80. This increase in the number of risers would apply to all of the alternatives and would increase the project costs over those presented in Table 7.2.2-1. However, the relative difference between the alternatives would not change. Therefore, the recommended outfall system is a rock-lined concrete tunnel with an 80-riser diffuser. The tunnel length and diameter will depend on the outfall site selected and on the selection of a gravity-flow or pumped-flow outfall system.

7.2.3 SUMMARY OF OUTFALL SYSTEM COMPARISONS

As was the case with the cross-Harbor tunnel, there is little to suggest that dredged pipeline construction is either economically or environmentally feasible. Preliminary analysis also suggests that a mixed technology, tunneling and dredged pipe, is considerably more costly and environmentally disruptive than tunneling alone. Accordingly, all alternatives discussed in this document are based on the construction of a tunnel to the discharge point. The tunnel will be constructed from a single shaft located on Deer Island. The length of tunnel required to reach the most distant site is at or near the feasible limit of construction from a single heading. Also, tunnels to the farthest sites are at the limit of gravity flow, given currently-planned plant hydraulics. Thus more distant sites (beyond site 5.0) are likely to require two headings (including an intermediate shaft) and an effluent pumping station. Figure 7.2.3-1 shows the location of the candidate sites, the distance of each site from shoreline, and the depth of water at each of the locations.

TABLE 7.2.2-1

COST SUMMARY FOR ALTERNATIVE CONDUIT AND DIFFUSER TYPES TO SITE 2

Alternative	Description	Construction Cost, $Millions Conduit	Diffuser	Total
1	17-ft-diam. tunnel w/20-riser diffuser	85	44	129
2	17-ft-diam. tunnel w/8 riser & 8 pipe diffusers	85	50	135
3	17-ft-diam. sunken tube w/pipe diffuser	113	44	157
4	17-ft-diam. pipeline w/pipe diffuser	113	50	163
5	Two 12-ft-diam. pipes w/pipe diffuser	140	17	157
6	24-ft-diam. tunnel w/20-riser diffuser	113	44	157
7	24-ft-diam. tunnel w/8 risers & pipe diffusers	113	50	163
8	24-ft-diam. sunken tube w/pipe diffuser	266	17	283
9	24-ft-diam. pipeline w/pipe diffuser	206	17	223
10	Two 17-ft-diam. pipelines w/pipe diffuser	241	17	258

Notes:

1. Alternatives 1 through 5 would be coupled with an effluent pumping station.

2. Alternatives 6 through 10 are for gravity flow systems.

7.3 DESCRIPTION OF OUTFALL CANDIDATE SITE LOCATIONS

The candidate sites can best be understood by first describing the circulation, sediment depositional patterns, and resource distribution within the area. Understanding these patterns provides a better basis for understanding the evaluation of environmental (outfall) and engineering criteria. Table 7.3-1 shows the design, schedule, and cost considerations for each candidate outfall site.

7.3.1 CIRCULATION

The circulation among candidate sites varies rather markedly. Two zones of circulation exist: a nearshore zone consisting of Sites 2.0, 2.5, and 4.0 on the north, and Site 3.0 on the south, and an offshore zone, consisting of Sites 4.5 and 5.0 on the north, and Site 3.5 on the south. Circulation patterns in the nearshore zone are most strongly influenced by tidal action, while those in the offshore zone are influenced not only by tidal action, but by the large-scale circulation of Massachusetts Bay itself.

This difference among zones has a large impact on outfall site selection. First, the direction of net circulation varies. At the nearshore sites, net circulation has a dominant east-west trend. In contrast, the offshore locations have a strong north-south trend. Secondly, the average dispersive capacity of the outermost sites is three to four times greater than the capacity of the innermost sites.

7.3.2 SEDIMENT DEPOSITIONAL PATTERNS

The sediment depositional patterns of the study area also vary. Two broad types of bottom characteristics are found: erosional, where the bottom is devoid of accumulated sediment, and depositional, where there are accumulations of sediment. A third category has also been identified: a transitional area where material is deposited for short periods but is transported either during storms or during other physical events. However, for purposes of this study, ultimate depositional and erosional areas are of greatest importance for long-term placement of an effluent discharge. The distinction is important because many pollutants concentrate themselves in the sediment and this can be magnified in the food chain. The difference in depositional patterns also provides an indicator of the relative vigor of the mixing of adjacent waters.

The areas adjacent to Sites 3.5 and 5.0 are best described as erosional, where the bottom is composed mostly of rock or cobbles with little overlying sediment. All other sites are considered depositional, in that there are broad areas of accumulated sediments. Within these areas there are apparent trends in the sediment geochemistry, which suggest that areas around Site 2.5 concentrate pollutants to a higher degree than adjacent regions. This would suggest that this area may serve as a long-term reservoir of sediments, and would focus pollutants in this zone.

TABLE 7.3-1

SUMMARY OF RECOMMENDED OUTFALL SYSTEMS

	Tunnel Inside Diameter (ft)	Total Tunnel Length(1) (ft)	Start Engineering (date)	Award Construction Contract (date)	Complete Construction(2) (date)	Project Cost(3) (million dollars)
Site 2	22	28,000	1/88	9/90	8/94	276
Site 2.5	23	35,000	1/88	9/90	8/94	312
Site 3	23	38,000	1/88	9/90	8/94	333
Site 3.5	24	42,000	1/88	9/90	12/94	387
Site 4	24	43,000	1/88	9/90	12/94	389
Site 4.5	24	45,000	1/88	9/90	12/94	388
Site 5	25	54,000	1/88	9/90	5/95	468

Notes:

(1) Total tunnel length includes 6,600 ft of tunnel under the diffuser.

(2) Construction completion date requires that the contract be awarded in the fall of 1990, mobilization occur over the winter, and construction begin in the spring of 1991.

(3) Project costs represent September 1986 dollars and include a 35-percent allowance for engineering and contingency costs.

Modeling of the sediment deposition patterns also shows the same effect. Differences in sediment rates lead to the conclusion that nearshore sites accumulate sediments at approximately five times the rate of offshore sites.

7.3.3 MARINE RESOURCES

Several marine resources now exist in the study region and adjacent areas. These include recreational uses of marine waters such as boating and fishing, commercial uses such as lobstering and fishing, and other resources which support these recreational and commercial activities.

Recreational uses of the regions around the study area are concentrated in closer proximity to the nearshore sites. Major regional beaches exist in Hull, Revere, and on the Nahant Bay side of the Nahant peninsula. Smaller, local beaches dot the entire coastline. Recreational boating and fishing are also concentrated nearer to the nearshore sites.

Active commercial fisheries are distributed throughout the region. Lobstering is more intensely practiced at sites inward of Sites 4.0 and 3.5, while trawling occurs at most locations except at Site 3.5. Fisheries statistics suggest that nearshore sites are more productive and diverse than are the offshore sites.

The distribution of marine resources closely follows the commercial use of the region. In addition, areas within three miles of the shoreline are closed to commercial fishing during certain times of the year because of the presence of winter flounder spawning grounds and in an attempt to distribute fishing activities more uniformly.

7.4 COMPARISON TO CRITERIA

Each candidate outfall location has been evaluated based on a series of evaluation criteria. The criteria are divided into four categories; environmental, technical, institutional, and cost. For more complete details regarding the evaluation of each site, the reader should refer to the Appendices described in Table 7.4-1. This section describes how well each site would meet the specified criteria. Table 7.4-2 presents the ratings of the individual sites, as well as technical information on various measures of acceptability. This section presents a comparison of forecasted future conditions for the various criteria. Information concerning other initiatives that might be undertaken by MWRA (particularly with regard to Water Quality Criteria and Standards) is presented more fully in Section 8, Detailed Evaluation of Recommended Plan.

7.4.1 ENVIRONMENTAL CRITERIA

Ability to Meet EPA Ambient Water Quality Criteria

The EPA Water Quality Criteria are used to evaluate the potential for adverse impacts on marine biota and human health from constituents present within the primary and secondary effluent.

TABLE 7.4-1

APPENDICES SUPPORTING OUTFALL EVALUATION

Criteria	Appendix
Ability to meet Water Quality Criteria	A
Ability to meet Massachusetts Water Quality Standards for Temperature, pH and Dissolved Oxygen	A
Avoidance of Adverse Sediment Accumulation	A, B
Avoidance of Areas of Important Habitat	B
Ability to Protect Local Species from Adverse Stress	A, B
Ability to Meet Water Quality Criteria to Prevent Taste and Odors	A
Conformance with State Coliform Standards	A
Maintenance and Enhancement of Aesthetic Conditions	A, B
Protection of Shoreline Areas	A, B
Protection of Commercial On-the-Water Activities	B, E
Protection of Marine Archaeology	B
Construction Traffic and Noise	B

TABLE 7.4-2
OUTFALL SITING CRITERIA SUMMARY TABLE

Criterion	Site 2	Site 2.5	Site 3	Site 3.5	Site 4	Site 4.5	Site 5
Ability to Meet EPA Water Quality Criteria	Good	Good	Good	Good	Good	Good	Good
a. Proportion of constituents that meet criteria for primary treatment effluent.	48/60	48/60*	48/60	48/60*	48/60	48/60*	49/60
b. Proportion of constituents that meet criteria for secondary treatment effluent.	53/60	53/60*	53/60	53/60*	54/60	54/60*	55/60
c. Average percent reduction needed to meet criteria for primary treatment.	91	89*	90	85*	87	84*	80
d. Average percent reduction needed to meet criteria for secondary treatment.	54	45*	50	34*	36	27*	17
Ability to Meet Massachusetts Water Quality Standards for Temp. DO & pH	Fair	Fair	Fair	Good	Excellent	Excellent	Excellent
a. Proportion meeting Temperature and pH Standards	2/2	2/2	2/2	2/2	2/2	2/2	2/2
b. Minimum Dissolved Oxygen Levels							
- Under primary treatment effluent	5.7	6.1*	5.7	7.0*	6.5	6.9*	7.2
- Under secondary treatment effluent	6.7	7.1*	6.7	8.0*	7.5	7.9*	8.2

NOTES:

- * Interpolation
- M Meets standard under all conditions
- [1] Only one constituent (2,4-dichlorophenol) may be a problem.
- NA Not available
- N/A Not applicable

TABLE 7.4-2
OUTFALL SITING CRITERIA SUMMARY TABLE
(Continued)

Criterion	Site 2	Site 2.5	Site 3	Site 3.5	Site 4	Site 4.5	Site 5
Avoidance of Adverse Sediment Accumulation	Average	Poor	Good	Excellent	Average	Good	Excellent
a. Maximum Sedimentation Deposition Rate ($g/m^2/d$)	1.55	1.24*	1.02	0.68*	0.92	0.63*	0.34
b. Sediment grain size, % silt and clay	7.33	50	2	Rocky	16.67	10.33	Rocky
c. Existing, mean total PAHs in sediment, mg/g	1.146	14.012	0.054	Rocky	1.371	1.919	Rocky
d. Existing, mean total PCBs in sediment, mg/g	0.06	0.11	0.02	Rocky	0.05	0.06	Rocky
e. Existing, mean sum of metals in sediment, mg/g	58.65	180.68	112.39	Rocky	143.08	154.56	Rocky
Avoidance of Areas of Important Habitat	Good	Good	Good	Excellent	Good	Good	Excellent
a. Distance to nearest regulated flounder spawning area, miles	0	0.89	0.59	2.66	2.54	3.79	5.27
b. Distance to nearest whale sightings, miles	6.27	5.45	5.09	3.67	4.02	2.84	1.36
c. Distance to nearest commercial shell-fishing area, miles	5.27	6.51	3.79	6.39	7.63	8.4	10.12
d. Expert score based on abundance of habitat and catch	1.07	0.83	1.18	0.12	0.59	0.83	0.12

NOTES:

- * Interpolation
- M Meets standard under all conditions
- [1] Only one constituent (2,4-dichlorophenol) may be a problem.
- NA Not available
- N/A Not applicable

TABLE 7.4-2
OUTFALL SITING CRITERIA SUMMARY TABLE
(Continued)

Criterion	Site 2	Site 2.5	Site 3	Site 3.5	Site 4	Site 4.5	Site 5
Ability to Protect Local Species from Adverse Stress	Average	Poor	Average	Good	Average	Average	Good
a. Stress: expert score based on REMOTS data (1=Low, 10=High)	5	1	3	9	5	7	7
b. Ability to Meet EPA Water Quality Criteria	Good	Good	Good	Good	Good	Good	Good
c. Ability to Meet Massachusetts Water Quality Standards	Fair	Fair	Fair	Good	Excellent	Excellent	Excellent
d. Avoidance of Adverse Sediment Accumulation	Average	Poor	Good	Excellent	Average	Good	Excellent
e. Avoidance of Areas of Important Habitat	Good	Good	Good	Excellent	Good	Good	Excellent
Ability to Meet Water Quality Criteria to Prevent Taste and Odor Problems [1]	Excellent M[1]	Excellent M[1]	Excellent M[1]	Excellent M[1]	Excellent M[1]	Excellent M[1]	Excellent M[1]

NOTES:

- * Interpolation
- M Meets standard under all conditions
- [1] Only one constituent (2,4-dichlorophenol) may be a problem.
- NA Not available
- N/A Not applicable

TABLE 7.4-2
OUTFALL SITING CRITERIA SUMMARY TABLE
(Continued)

Criterion	Site 2	Site 2.5	Site 3	Site 3.5	Site 4	Site 4.5	Site 5
Conformance with State Coliform Standards	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
a. Percentage of Time Meeting Coliform Standard	100%	100%*	99.9%	100%*	100%	100%	100%
Maintenance and Enhancement of Aesthetic Conditions	Poor	Fair	Average	Good	Good	Excellent	Excellent
a. Nutrient loading at specified conc., km2	77.62	51.35	61.11	36.45	25.08	18.44	11.78
b. Potential for increased primary productivity, expert score based on protection from nuisance blooms (1=Low, 10=High)	4	5	4	6	6	7	8
c. Frequency of plume contacting water surface, %	50	40.5*	43	37*	31	31*	31

NOTES:

- * Interpolation
- M Meets standard under all conditions
- [1] Only one constituent (2,4-dichlorophenol) may be a problem.
- NA Not available
- N/A Not applicable

TABLE 7.4-2
OUTFALL SITING CRITERIA SUMMARY TABLE
(Continued)

Criterion	Site 2	Site 2.5	Site 3	Site 3.5	Site 4	Site 4.5	Site 5
Protection of Shore Line Areas	Fair	Average	Average	Average	Average	Excellent	Excellent
a. Floatables on Beaches	None	None	None	None	None	None	None
b. Effluent Dilution at Beaches for Conservative Parameters							
Nahant	62	85*	40	119*	108	153*	198
Hull	95	120*	85	158*	144	188*	232
Winthrop	54	90*	92	134*	101	139*	177
Outer Islands	65	88*	87	142*	110	154*	198
c. Viruses on Beaches (viruses/liter)							
Primary Treatment							
Nahant	0.590	0.490	0.390	0.390	0.390	0.310	0.220
Hull	0.990	0.790	0.490	0.480	0.480	0.350	0.220
Winthrop	0.790	0.610	0.590	0.510	0.430	0.330	0.220
Outer Islands	0.590	0.470	0.690	0.520	0.360	0.280	0.190
Secondary Treatment							
Nahant	0.038	0.031	0.025	0.025	0.025	0.020	0.014
Hull	0.038	0.034	0.031	0.031	0.031	0.022	0.014
Winthrop	0.051	0.040	0.038	0.033	0.028	0.021	0.014
Outer Islands	0.038	0.030	0.045	0.034	0.023	0.017	0.012
d. Maintenance of aesthetics	Poor	Fair	Average	Good	Good	Excellent	Excellent

NOTES:

- * Interpolation
- M Meets standard under all conditions
- [1] Only one constituent (2,4-dichlorophenol) may be a problem.
- NA Not available
- N/A Not applicable

TABLE 7.4-2
OUTFALL SITING CRITERIA SUMMARY TABLE
(Continued)

Criterion	Site 2	Site 2.5	Site 3	Site 3.5	Site 4	Site 4.5	Site 5
Protection of Commercial, On-the-Water Activities	Fair	Fair	Fair	Average	Average	Good	Good
a. Number of commercial finfish landings reported, NMFS, 1986.	2795	2795	2795	697	2795	697	697
b. Species diversity index, trawls and gill nets, Battelle, 1987.	1.026	1.178	0.809	1.752	1.33	2.367	0
c. Mean annual finfish catch, no. of fish/ 1,000 m2, fall and spring tows, MDMF, strata 33 and 34, 1978-1986	608.8	608.8	608.8	608.8	556.3	556.3	556.3
d. Mean annual lobster trawl, catch, no. of lobsters/10,000 m^2, MDMF, Strata 33 and 34, 1978-1986	39.8	39.8	39.6	39.6	10.4	10.4	10.4
e. No. of recreational sport fish species observed at each site, MDMF and Battelle, 1986-1987	11	8	12	10	11	11	9
f. Inteference with Navigation	Good	Good	Good	Good	Excellent	Good	Excellent
Protection of Marine Archaeology	Poor	Fair	Good	Good	Good	Good	Excellent
Expert score, based on documentary research characterizing the proximity of outfall site to reported shipwreck (1=High, 10=Low)	10	8	6	6	6	5	2

NOTES:

- * Interpolation
- M Meets standard under all conditions
- [1] Only one constituent (2,4-dichlorophenol) may be a problem.
- NA Not available
- N/A Not applicable

TABLE 7.4-2
OUTFALL SITING CRITERIA SUMMARY TABLE
(Continued)

Criterion	Site 2	Site 2.5	Site 3	Site 3.5	Site 4	Site 4.5	Site 5
Construction Traffic and Noise	Good	Average	Average	Average	Fair	Fair	Poor
a. Volume of tunnel duration spoils, 100 yd3	770	1040	1130	1250	1280	1440	1860
b. Duration of Construction (months)	47	47	47	51	51	51	56
Reliability	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
a. Frequency of disruption	0	0	0	0	0	0	0
Flexibility	Average	Average	Average	Good	Good	Excellent	Excellent
Constructibility	Excellent	Excellent	Excellent	Good	Good	Good	Fair
a. Duration of Construction (Months)	47	47	47	51	51	51	56
Operational Complexity	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Power Needs	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTES:

- * Interpolation
- M Meets standard under all conditions
- [1] Only one constituent (2,4-dichlorophenol) may be a problem.
- NA Not available
- N/A Not applicable

TABLE 7.4-2
OUTFALL SITING CRITERIA SUMMARY TABLE
(Continued)

Criterion	Site 2	Site 2.5	Site 3	Site 3.5	Site 4	Site 4.5	Site 5
Quantity of Spoils (Cubic Yards X 1,000)	770	1040	1130	1250	1280	1440	1860
Capital Costs ($Millions)	275	311	332	375	376	387	467
Timely Implementation	Modest	Modest	Modest	Moderate	Moderate	Moderate	Moderate
a. Duration of Construction (Months)	47	47	47	51	51	51	56
Permiting	Extensive	Extensive	Extensive	Extensive	Extensive	Extensive	Extensive
a. Number of permits	8	8	8	8	8	8	8
Internal/External Coordination and Demand for Unique Resources	Extensive	Extensive	Extensive	Extensive	Extensive	Extensive	Extensive

NOTES:

- * Interpolation
- M Meets standard under all conditions
- [1] Only one constituent (2,4-dichlorophenol) may be a problem.
- NA Not available
- N/A Not applicable

Sites were compared based on their ability to meet the Water Quality Criteria at the edge of the mixing zone for both primary and secondary treatment as well as the degree to which these criteria are met in terms of a factor of safety. Using the Water Quality Criteria resulted in 60 tests; each site was assessed as to its ability to meet these 60 tests.

For the interim period of primary treatment, Site 5 meets 49 out of 60 criteria, while the remaining sites meets 48 criteria. For secondary treatment, Site 5 meets 55 out of 60 criteria; Sites 4 and 4.5 meet 54 criteria; and Sites 2, 2.5, 3, and 3.5 meet 53 criteria.

In terms of a factor of safety, the percent reduction of constituents in the effluent required to meet Water Quality Criteria was assessed. For primary treatment, the sites require between 80 and 91 percent reduction, while for secondary treatment, between 17 and 54 percent reduction is required. For both primary and secondary treatment, the offshore sites perform better in comparison to criteria and require less reduction than the nearshore sites.

A distinction between candidate sites cannot be drawn based on this criteria; each site has a "good" ability to meet the criteria. No site meets all of the criteria for primary or secondary treatment. However, all sites have the ability to meet the majority of the criteria. Sites further out require less pollutant reduction to meet the criteria.

Ability to Meet Massachusetts Water Quality Standards for Temperature, pH, and Dissolved Oxygen

The Massachusetts Water Quality Standards are used to evaluate the potential for adverse impact on marine biota from conventional pollutants from the primary and secondary effluent. Sites were compared based on their ability to meet Water Quality Standards for both primary and secondary treatment. No safety factor was considered in this assessment.

For each site, Water Quality Standards for temperature and pH will be met for both primary and secondary treatment. For the dissolved oxygen (DO) standard, all sites meet the standard for secondary treatment. For primary treatment, all sites except Sites 2 and 3 meet the DO standard under all conditions. Site 2.5 would meet the standard by the smallest degree, with the offshore sites performing better than the inshore sites.

From this assessment, the only factor that can be used to distinguish between sites is that of meeting the DO Standard for the 5-year period of primary treatment. Only Sites 4, 4.5, and 5 meet the DO Standard and are rated as "Excellent." Sites 2 and 3 do not meet the Standard, however, they are only slightly below and are rated as "Fair." Site 2.5 meets the Standard, but is only slightly above and is rated "Fair." Site 3.5 is rated "Good" because the value is an interpolation between Sites 3 and 5, and the lower rating was used to remain conservative in the analysis.

Avoidance of Adverse Sediment Accumulation

This criterion is used to evaluate the potential impact on benthic biota as a result of deposition of contaminated materials from the secondary wastewater discharge. Sites were compared based on predicted sedimentation rates from a discharge at a particular site and the potential for a particular site to be located within a short- or long-term depositional area, as measured by sediment grain size and photographic evaluation. The existing concentrations of contaminants in the sediment at each site were also used as a basis of comparison.

The maximum sedimentation rate information is obtained from the far-field modeling efforts. There is an obvious trend of less accumulation as a function of distance offshore, with Site 5 receiving the lowest maximum sedimentation rate. To assess whether an area is located within a depositional area and has the potential for adverse sediment accumulation, three parameters were evaluated: grain size where a high percentage of silt and/or clay would represent a depositional area; the total polynuclear aromatic hydrocarbons (PAHs) contained within the sediment; and PCBs and metals contained within the sediment. It should be noted that Sites 3.5 and 5.0 were rocky and did not permit standard sampling for sediment analyses. The general term "rocky," however, implies that the area is non-depositional. This study indicates that these areas are non-depositional, but confirmation of this hypothesis would be necessary in future "Mass Bay" studies.

The percentage of silt/clay was relatively low for all sites except Site 2.5. Site 2.5 also had the highest PAHs, PCBs, and metal levels among the sites. This indicates that Site 2.5 is probably situated within a depositional area. The remaining sites (where samples could be taken) have significantly lower percentages of silt/clay and PAHs, indicating a smaller potential to be in a depositional area.

Sites 3.5 and 5 are rated "Excellent" with respect to this criterion, since both sites are in non-depositional areas and limited sediment accumulation would occur. While somewhat greater sediment accumulation would occur at Sites 4.5 and 3, the sites appear to be within a non-depositional area, based on sediment grain size distribution. They have been rated as "Good." A suspected depositional area occurs at Site 2.5 (based on sediment grain size). The Presidents Roads site would affect the Harbor (which is a depositional area). Thus, these two sites have been rated "Poor." Sites 2 and 4 were rated as "Average" because of a higher sediment accumulation rate and the possibility of being within or near a depositional area.

Avoidance of Areas of Important Habitat

This criterion is used to evaluate the potential impacts of candidate outfall locations on resources important to the regional ecosystem. Sites were compared based on distance to known spawning areas, unique marine habitats and commercial fisheries.

Site 2 is located very close to the Division of Marine Fisheries' three-mile winter flounder fishing boundary, and is considered to be within an area of important habitat. However, it is the furthest site from the offshore whale habitats and is reasonably far away from shellfishing areas. Site 3 is very close, although outside, of the flounder fishing area. It is closer to whale sitings, and relatively close to shellfishing areas. For the remaining sites, the further offshore the site is, the further it is from spawning, fishing, and shellfishing areas, and the closer it is to the whale migratory areas.

No known unique marine resources exist within the study area, thus this measure is not site-determinative. Sites 3.5 and 5 rate "Excellent" for this criterion because of their distance from known spawning areas, and because they border, but are not directly situated in, a major commercial fishery. The remaining sites, Sites 2, 2.5, 3, 4, and 4.5 are located at varying distances from commercial shellfishing areas, flounder spawning areas, and whale siting areas. While Site 2, for example, is within the flounder spawning area, it is the furthest removed from whale siting areas. These remaining five sites were collectively rated as "Good."

Ability to Protect Local Species from Adverse Stress

This criterion measures the degree to which locally important marine species may be stressed by a wastewater discharge at a particular site. Sites were compared based on their existing successional infaunal characteristics and the diversity of the benthic community, ability to meet EPA Aquatic Life Water Quality Criteria and State Water Quality Standards, Avoidance of Important Habitats, and sediment accumulation characteristics.

In order to assess a site's ability to protect locally important species, five measures of acceptability were used. Only one of these measures is from actual data, while the other four are criteria previously discussed. The first indicator is stress, as measured through a REMOTS score based on indications of benthic community stress. Site 2.5 had a low stress score, indicating the greatest community stress. This is another indication of the depositional area hypothesis, described above. Sites 2, 3, 4, 4.5, and 5 all had intermediate scores, and Site 3.5 had a high score, indicating little community stress.

The EPA Water Quality Criteria, Massachusetts Water Quality Standards, Avoidance of Adverse Sediment Accumulation and Avoidance of Areas of Important Habitat were assessed as the next set of indicators.

As discussed above, all sites are rated "Good" based on EPA Water Quality Criteria. The outer sites were rated "Excellent" while the inner sites were rated lower for achievement of State Water Quality Standards. For the avoidance of adverse sediment accumulation and avoidance of important habitats, Sites 3.5 and 5 were rated "Excellent." The remaining sites were rated "Good" to "Poor" as a result of increased sediment accumulation and the existence of important habitats. Also, based on available knowledge of the benthic environment, the benthic infauna appear healthy. Based on indications of infaunal community stress, Sites 2, 3, 4, and 4.5 were rated "Average," and Site 2.5 was rated "Poor." Because Sites 3.5 and 5 are located in non-depositional areas with low infaunal community stress and are away from important habitats, these sites rated "Good."

Ability to Meet Water Quality Criteria to Prevent Taste and Odors

This criterion is used to evaluate the potential to impart objectionable taste and odor to marine biota. Sites are compared based on their ability to meet specific criteria for organoleptic contaminants. The effluent concentrations of the organoleptic contaminants were compared against taste and odor criteria. For the known taste and odor-causing compounds, with the exception of 2,4 dichlorophenol, each site would meet the pertinent criteria. Data on 2,4 dichlorophenol in the effluent is not readily available and comparisons could not be made.

All sites are equally capable of meeting published criteria, and are all rated "Excellent."

Conformance with State Coliform Standards

State Coliform Standards are used to evaluate the impact of a wastewater discharge on the ability to harvest shellfish, and the extent to which contact recreation can occur at known recreational areas. Sites are compared based on their ability to meet the State Coliform Standard at the edge of the mixing zone.

Based on the results of wastewater treatment processes assessment, it was assumed that a chlorination-based disinfection alternative would be used at the treatment facility. The discharge, by virtue of the National Pollutant Discharge Elimination System Permit, must meet a certain residual coliform level. For the NPDES permit, the discharge must contain less than 400 fecal coliform per 100 ml of effluent. In accordance with the Massachusetts Clean Water Act, the discharge must not degrade the water quality outside the acceptable range of the water quality classification. Since all sites are in Class SA waters, the coliform levels must be below FDA and state limits for shellfish harvesting; coliform levels in the water must not exceed 14 fecal coliform per 100 ml of ocean water.

Only one site, Site 3, did not meet the coliform standards under all conditions; a discharge in this area may require slightly greater disinfection than the other sites.

Assuming that this level will be met at the end of the pipe via disinfection, the State Coliform Standard can then be met at all sites. Therefore, all sites are rated "Excellent."

Maintenance and Enhancement of Aesthetic Conditions

This criterion is used to evaluate the potential for adverse impacts to the aesthetic conditions of the region, as measured by a surfacing plume, and excessive increases in primary productivity. Sites were compared based on the frequency that the effluent plume would be expected to reach the surface, nutrient loadings, dispersive characteristics of a site, and the potential for nuisance algal blooms.

Nutrient loadings and the dispersive characteristics of a site were combined into one measure; the maximum area in square kilometers which would have a specific concentration of nutrients

(See Appendix B). As expected, the area with the greatest dispersive capability, around Sites 5 and 4.5, would produce the smallest area with the specified nutrient concentration, and would provide the most protection from nuisance algal blooms. The inshore sites would have larger areas containing the specified concentration, and would provide a lower degree of protection.

The second measure was a relative rating from the primary productivity program, used to assess the protection of the environment from nuisance algal blooms. Based on this rating, Sites 2, 2.5, and 3 had the lowest scores. They would provide marginal protection against algal blooms. The offshore sites, Sites 3.5, 4, 4.5, and 5 have a greater capacity to minimize nuisance algal blooms.

The third measure was the percentage of time the plume surfaces. A surfacing plume allows nutrients to reach the photic zone, where they enhance primary productivity. Sites 4, 4.5, and 5 have the lowest percentage of surfacing plumes, 31 percent. Site 3.5 has a percentage of surfacing of 37 percent. The inshore sites have higher frequency of a surfacing plume of between 40 and 50 percent of the time.

Long-term transport, low frequency of plume surfacing, and the relatively low potential for nuisance blooms lead to a rating of "Excellent" for Sites 4.5 and 5. Site 4 is rated "Good," based on dispersive characteristics that are somewhat less energetic than those at Sites 4.5 and 5; Site 3 is rated "Average," based on the current moderate primary productive rates and the moderate potential for nuisance algal blooms. Site 3.5 is tentatively rated "Good," based on extrapolation between Sites 3 and 5. Site 2 is rated "Poor" because of the high potential for nuisance blooms and limited dispersive characteristics. A tentative rating of "Fair" was given for Site 2.5 because of the potential for algal blooms. This potential is somewhat lower than for Site 2, however.

Protection of Shoreline Areas

This criterion is used to evaluate the regional impacts of each candidate site as measured by concentrations of constituents at each sensitive shoreline area. Sites were compared based on the amount of floatable solids reaching the sensitive shoreline areas, effluent dilution at each shoreline, viral contamination at the shorelines and maintenance of aesthetics.

For both primary and secondary treatment, no floatables will be discharged, therefore no floatables will reach any beaches.

Effluent dilution at each shoreline is the average dilution of the effluent at the nearest land masses. The dilution is a function of distance to the shoreline, among other factors, and as expected, the nearshore sites allow much lower dilution at shoreline areas. Dilution from nearshore sites range from 40 to 120, depending on the site and the nearest shoreline. The offshore sites, particularly Sites 4.5 and 5, allow dilution at shorelines to reach between 139 to 232.

The second measure is the amount of viruses from the discharge affecting shoreline areas. For both primary and secondary treatment, the offshore sites minimize the amount of viruses at shores to some degree greater than inshore sites.

The final measure deals with the assessment of the previous criteria, Maintenance and Enhancement of Aesthetics, described above.

Sites 4.5 and 5 provide a large degree of dilution and dispersion characteristics, while the inner sites provide smaller dilution and dispersion. For viral contamination, Sites 3.5, 4, 4.5, and 5 provide similarly high protection. With regard to aesthetics, the outside sites provide "Excellent" protection while inner sites provide progressively lower protection. By combining these results, it becomes clear that Sites 4.5 and 5 are rated "Good." Those sites nearer to the shoreline, Presidents Roads and Site 2, have significant effects on shoreline areas, and are rated "Fair." Sites 2.5, 3, 3.5, and 4 are rated as "Average," since each affects the nearest sensitive shoreline to approximately the same degree; each are located near recreational areas, provide less protection from viral infection.

Protection of Commercial On-the-Water Activities

This criterion is used to evaluate the potential for construction activities and/or operation of the diffuser to interfere with navigation or with commercial fishing. Sites are compared based on the relative abundance and catch from commercial fishing and shellfishing activities, proximity of each site to navigational channels, and the actual commercial activity occurring at a particular site.

There are six measures for this criteria, of which five are related to fisheries and one is related to navigation. For commercial finfish and lobsters, the inshore sites support the largest fishery resources. The offshore sites, Sites 4.5 and 5, and to some extent Site 4, have signficantly lower catch potential. Indications from local fishermen are that Sites 2, 2.5, 3, 4, and 4.5 are heavily utilized for both lobster and finfish fishing. Site 5 supports a smaller finfish and lobster resource. Site 3.5 appears to be an untrawlable area, thus finfishing is minimized. However, a significant lobster fishery is supported at Site 3.5.

With regard to restrictions to navigation, Sites 5 and 3.5 are a signficant distance from shipping lanes. The remaining sites are closer but can be avoided relatively easily.

While operational impacts on navigation would be minimal at all sites, construction activities could impede safe use of Boston Harbor for commercial vessels. Sites 3.5 and 5 would rate "Excellent" for protection of navigation, since both would be away from shipping channels. The remaining sites would rate "Good" for the protection of navigation. Sites 4.5 and 5 were each rated "Good" for the protection of commercial fishing, since commercial fishing for lobster and finfish at these locations is not very significant. President Roads and Sites 2, 2.5, and 3

show similarly high commercial finfish and lobster fishing activities. These sites were collectively rated as "Fair." Sites 3.5 and 4 are somewhat different from the remaining sites. Site 3.5 has a large lobster fishery and small finfish fishery, whereas Site 4 has a large finfish fishery and small lobster fishery. Therefore, these sites were rated "Average."

Protection of Marine Archaeology

This criterion is used to evaluate the potential impacts that candidate outfall locations would have on historic/archaeological sites within Massachusetts Bay. Sites were compared based on the likelihood of the existence of historical shipwrecks within a three-mile radius of the outfall location. Generally, reported shipwrecks are most frequent in areas closest to shipping lanes, such as the Boston North Shipping Channel.

Site 5 is furthest from reported wrecks and is rated "Excellent." Sites 3, 3.5, 4, and 4.5 are all rated "Good." Outfall Sites 2 and 2.5 are rated "Poor" and "Fair," respectively, because of their proximity to shipping traffic in the Boston North Shipping Channel.

Construction Traffic and Noise

This criterion is used to assess the ease of controlling noise generated by construction activities, and minimizing traffic impacts. The construction methodology employed at all outfall sites is similar; the noise impacts associated with the candidate outfall locations differ only in terms of the duration of the construction period.

Based on the relative difficulty of controlling noise impacts, all sites are rated "Good."

Since it is likely that nearly all of the excavated materials from effluent tunnel boring and outfall diffuser construction will be removed by overwater transport for disposal or use at locations other than Deer Island, traffic impacts relative to Deer Island are considered "Excellent."

Both noise and traffic considerations are uniform for all outfall sites, in terms of their impact at any time during the construction period. However, due to the varying tunnel lengths and water depths at the outfall locations, the construction period over which these impacts will be experienced differ by duration. Since duration of these impacts is directly related to the volume of tunnel spoil removed from each outfall location, the volume of tunnel spoil was also used as an indicator of noise and traffic impacts. Using the factors of tunnel spoils and construction duration to assess traffic and noise, Site 2 is rated "Good," Sites 2.5, 3, and 4 are rated "Average," Sites 3.5 and 4.5 are rated "Fair" and Site 5 is rated "Poor."

7.4.2 ENGINEERING CRITERIA

Technical Criteria

Reliability

Reliability is used to assess the level of assurance that the outfall will continuously operate over the expected range of operating conditions throughout the life of the project. Sites were compared based on their ability to avoid service interruptions.

A properly designed and constructed effluent outfall would provide a high degree of assurance that it will operate continuously without service interruptions. Therefore each site was rated "Excellent."

Flexibility

This criterion is used to evaluate the ability of a site to respond to future conditions. Sites were compared based on their ability to meet current and future water quality criteria and standards.

Since future water quality criteria are not known at this time, the only quantitative measure is the ability to meet existing criteria. This measure is discussed above. A tightening of criteria in the future is possible. When constructing an outfall to meet the needs of a community for a century, these changes must be anticipated. While the best means to assure compliance with future criteria is through source control, a certain degree of initial flexibility is necessary.

While all of the candidate sites were rated "Good" for meeting current Ambient Water Quality Criteria, only Sites 4.5 and 5 are clearly rated "Excellent" for this criterion. Although Water Quality Criteria are currently met at Site 4, the degree to which these or more stringent criteria can be met in the future is somewhat limited. Therefore Site 4 is rated "Good." Through extrapolation between Sites 3 and 5, Site 3.5 was tentatively rated "Good." Due to the limited ability for the remaining sites to meet future water quality criteria, no distinction can be made between these sites; therefore Sites 2, 2.5, and 3 are rated "Average."

Constructibility

This criterion is used to assess the ability to construct the outfall at a particular site on schedule. Sites were compared based on their ability to comply with court-ordered target dates. The measure for this criterion is the duration of construction for the nearshore sites. For Sites 2, 2.5, and 3, the outfall and diffuser could be constructed in 47 months. For Sites 3.5, 4, and 4.5, the outfall could be constructed in 51 months. For Site 5, it could be constructed within 56 months.

The schedule for construction of the outfall tunnel and diffuser at all sites exceeds the July, 1994 target date contained in the federal court order. Sites 2, 2.5, and 3 are rated "Modest" because they deviate only slightly from the target date. Sites 3.5, 4, and 4.5 exceed the target date but precede the new primary plant start-up by several months. They thus are rated "Moderate." Construction at Site 5 would be completed concurrently with primary plant completion and thus is rated "Difficult."

Operational Complexity

This criterion is used to assess the degree of difficulty in the maintenance and control of the effluent outfall system. Sites were compared based on the levels of skill and attention required by plant operators to successfully operate the facilities.

Operation of the effluent outfall system is independent of the length of the tunnel, since the system is gravity-driven and control requirements are not excessively difficult. Therefore, all sites are rated "Not Applicable."

Power Needs

Since the outfall system is gravity-driven, there are no power needs and this criterion is not applicable to siting.

Quantity/Quality of Spoils for Disposal and/or Relocation

This criterion is used to assess the amount of materials removed from the tunnel. Sites were compared based strictly on the volume of tunnel spoils, since it is expected that tunnel spoils will be uncontaminated. The quantity of spoils is related to length of the outfall shaft. For Site 2, the shortest outfall, 770,000 yd^3 of material are expected, while for Site 5, spoils will exceed 1,800,000 yd^3.

Cost Criteria

For all other parts of the Deer Island Secondary Treatment Facilities Plan, costs are described as capital, operations and maintenance, and present worth. For the outfall, only capital costs are considered, because the alternatives involve only gravity-flow systems, and there are essentially no operating costs.

Capital Costs

Capital costs include costs to construct the facilities plus 35 percent to cover construction contingencies, administrative, engineering, and legal costs. Sites are compared strictly on the basis of capital costs of the outfall and diffuser.

The constraints that affect outfall costs include, but are not limited to, length of the tunnel, diameter of the tunnel, and geologic conditions of sedimentary materials. Capital costs are estimated to range from $275 million at Site 2 to $467 million at Site 5.

Institutional Criteria

Timely Implementation

The schedule for construction of the outfall tunnel and diffuser at all sites exceeds the July, 1994 target date contained in the federal court order. Sites 2, 2.5, and 3 are rated "Modest" in difficulty in achieving the schedule because they deviate only slightly from the target date. The estimated completion schedule for these three sites is 47 months. Sites 3.5, 4, and 4.5 exceed the target date but precede the new primary plant start-up by several months and thus are rated "Moderate" in difficulty. The outfall can be completed in 51 months at these three locations. Site 5 construction would be completed concurrently with primary plant completion and thus this site is rated "Difficult." An outfall tunnel to Site 5 will require approximtely 56 months to complete.

The projected tunnel construction schedule is based on current assumptions regarding rock strength and uniformity. However, there is little information regarding the rock characteristics at the tunnel depth along the proposed route. Unexpected rock conditions could affect the schedule adversely and hinder the MWRA's ability to meet the project's schedule. A detailed geotechnical field program, consisting of a series of deep rock borings along the tunnel alignment, is required to establish the final design parameters. To meet the projected completion date, the geotechnical investigations must begin in the spring of 1988.

Permitting

This criterion measures the relative difficulty in obtaining the necessary permits. Sites are compared in relation to the number and types of approvals required.

The permitting for each alternative is equally "Extensive" in the number and types of approvals required. It is possible, however, that a higher level of scrutiny may be applied to obtaining these permits for the inner Harbor sites due to concern about shoreline impacts. The major permits will include: (1) a Permit for Structures or Work in Navigable Waters from the U.S. Army Corps of Engineers; (2) a Private Aid to Navigation Permit from the U.S. Coast Guard; (3) a Water Quality Certification and a Chapter 91 Waterways License from the Massachusetts Department of Environmental Quality Engineering (DEQE); (4) A Consistency Review by the Massachusetts Coastal Zone Management (CZM) Program; (5) a Section 106 Historic Preservation Review from the Massachusetts Historical Commission; (6) a Finding of No Significant Impact (FONSI) from the Environmental Protection Agency; (7) a Secretary's Certificate from the Massachusetts Executive Office of Environmental Affairs (EOEA); and (8) local Orders of Conditions reviews and approvals.

Internal and External Coordination and Demand for Unique Resources

This criterion is a measure of the relative degree to which MWRA must interact with outside agencies and within itself. Sites are compared based on the number of projects competing for necessary resources.

The internal and external coordination requirements and the demand for unique construction resources are similar for all candidate sites. In each case, there must be "Extensive" coordination with two other construction projects with similar resource requirements: the Inter-Island Wastewater Conveyance System which is part of MWRA's STFP; and the Third Harbor Tunnel being constructed by the Massachusetts Department of Public Works. To ensure the availability of labor, equipment, and supplies it will be necessary to be cognizant of the requirements of all three projects.

7.5 SUMMARY OF COMPARISON OF SITES

In evaluating alternatives, four broad categories of criteria have been established. These include:

- o Environmental criteria, which focus on the environmental differences between sites and measure the potential impacts of an outfall located at candidate sites;

- o Engineering criteria which include the following:

  - Technical criteria, which focus on engineering issues such as reliability and constructibility;

  - Cost criteria, which present the financial investment necessary to construct and operate the facilities at candidate sites;

  - Institutional criteria, which assess the differences between sites, the time required for construction, and the coordination required among a wide variety of public and private organizations and agencies.

7.5.1 ENVIRONMENTAL CRITERIA

In developing an overall evaluation of the environmental suitability of different sites as locations of the outfall, Sites 4.5 and 5 have been identified as preferred sites. The rationale for this conclusion follows:

- The offshore sites offer the greatest potential for meeting numerical water quality criteria and standards. It is important to note that at all locations, source control of certain compounds to meet water quality criteria will be required. However, the outer sites, because they provide more robust mixing, provide the greatest opportunity to meet or exceed these criteria.

- The offshore sites minimize problems associated with sediment accumulation and concentrating of pollutants. While there are no criteria currently available which define the importance of any specific level of contaminants in the sediments, the differences in deposition and chemistry demonstrate that offshore sites are less contaminated than inshore sites.

- The offshore sites present the least opportunity for adverse impact on shoreline resources and aesthetics. The potential for creating nuisance algal blooms, which can be both an aesthetic and an environmental concern, is significantly less at the offshore sites because of their distance from other sources of contaminants and the more robust mixing present there. Moreover, the discharge will be trapped low in the water column more frequently at the farther sites. This serves to minimize algal blooms and prevent movement of the effluent onto the shoreline.

- Sites further from shore are least likely to impact commercial uses of the marine resources. While resources exist throughout the region, they are most abundant near the shore. Most notably, lobstering is conducted more extensively at Sites 2, 2.5, 3, and 3.5, and less so at 4, 4.5, and 5. Finfishing is less productive at Sites 3.5, 4.5, and 5. Areas within three miles of the coast are closed to fishing during certain times of the year because of their importance as spawning grounds, indicating again the sensitivity of these nearshore sites.

- Because offshore sites result in fewer impacts as measured by long-term mixing, sedimentation, and avoidance of important resource areas, they are judged to provide the greatest protection of local species from adverse stress.

- Finally, the outer sites offer the least potential for impacts on historical shipwrecks.

In most other respects, the sites are equal. It is generally possible to meet State Coliform Standards at all locations, and all alternatives have similar impacts with regard to noise and traffic.

7.5.2 ENGINEERING CRITERIA

Technical Criteria

All alternatives are essentially the same when evaluated according to the technical criteria. All sites are judged to be equal in terms of reliability, operational complexity, and power needs because they are all gravity-flow designs. This would translate to high reliability, low operational complexity, and minimal power needs.

In all cases, the construction of the alternatives is considered to be aggravated because of the nature of the expected method of construction. Sites further from shore are slightly more technically complex because of the difficulty of constructing such a long bore from a single heading, and because of the greater volume of tunnel spoils associated with the longer tunnel. Work underway suggests, however, that the greater volume of spoils may not be as negative a factor as previously thought, since it may be possible to use the spoils either as aggregate for low- strength concrete, or as part of the Third Harbor Tunnel backfill requirements.

In terms of the final technical criterion, flexibility, the offshore sites are assessed to be better. This criterion measures the ability of any alternative to accommodate future changes, such as modified water quality requirements. As noted in the environmental review section, the sites further offshore have a greater capacity to accommodate such changes.

Cost Criteria

The cost criteria represent the financial investments which must be made for each of the alternatives. For most of the projects in the Deer Island STFP, cost criteria include considerations of both capital and operating costs. The outfall alternatives under investigation have essentially no operating costs because all designs are for a gravity-flow system. Accordingly, the most appropriate comparison is on the basis of construction costs. The following table shows the differences in estimated construction costs:

Estimated Construction Costs ($ Millions)

Site	Cost*
2	$275
2.5	311
3	332
3.5	375
4	376
4.5	387
5	467

*Based on an Engineering News Record Construction Cost Index of 4440 for September, 1987.

It should be noted that the above costs include between $120 and $150 million for construction of the diffuser, with the remainder of the costs associated with the tunnel itself. Any option that would involve constructing a diffuser at a site and then changing that site location at a later date would be prohibitive in that it would incur a financial penalty of at least $120 million.

Institutional Criteria

The institutional criteria measure the differences among sites for ease of implementation (coordination requirements, permitting), and scheduling impacts, as well as the demand for unique construction resources. All sites have the same rating when measured by these tests.

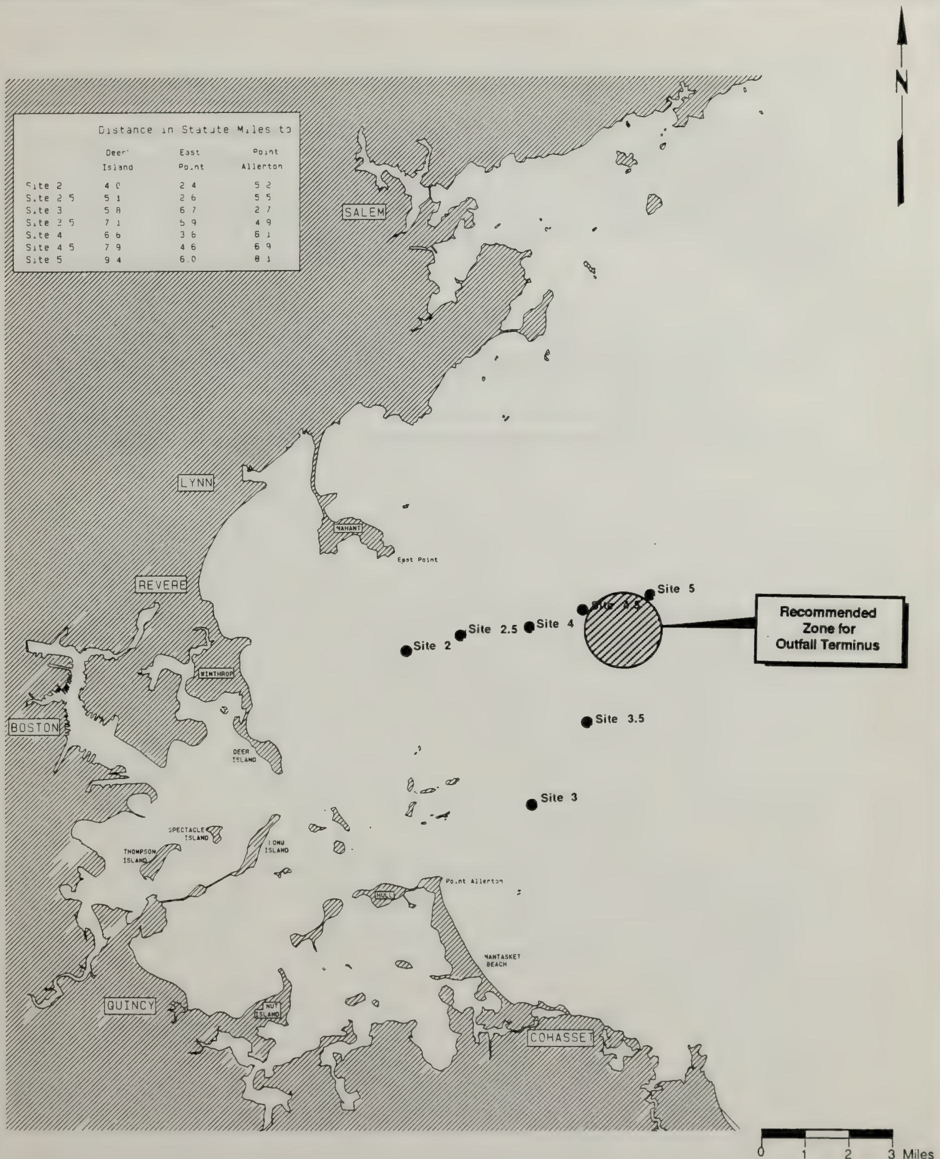
The differences in estimated construction time are small - ranging from 47 months at the inner sites to 56 months at the furthest site. Moreover, the permitting requirements and construction resources are the same regardless of the site. And finally, the outfall project cannot be built in sequentially-phased operating elements. Accordingly, all alternatives were not considered to be amenable to phasing.

7.6 RECOMMENDED PLAN

The proposed effluent outfall should be located in the region bounded by Sites 4.5 and 5 (See Figure 7.6-1). A comparison of Sites 4.5 and 5 indicates that Site 5 offers some additional environmental benefit, but cost considerations favor Site 4.5. The early design phase of the outfall should be focused on collecting detailed topographical and geotechnical information on the bottom in this region to facilitate the selection of the construction site. Additional monitoring will also be used to determine if there are any environmental factors that might indicate a clearer preference for the location of the diffuser within the region recommended. The reader is referred to Section 8, Detailed Evaluation of the Recommended Plan, for recommended monitoring information.

These two sites represent the optimum mix of characteristics of good outfall sites: they are within the large-circulation patterns of Massachusetts Bay, and therefore provide the most robust long-term mixing. They are in regions of lesser potential sediment accumulation, thereby avoiding problems associated with concentrating pollutants in bottom sediments. They are located at a greater distance from intensely utilized nearshore resources, thereby avoiding the potential for disruption. And finally, they can all be reached by gravity within a reasonable timeframe consistent with the spirit of the court-ordered target dates.

The other shoreward sites do not represent viable options for the long-term discharge of effluent from the Deer Island facility. Outfalls placed in these locations are marginally acceptable when measured by current numerical criteria. But they are not acceptable when measured against non-numeric criteria. Of particular concern are the greater sediment accumulation that would occur at these sites, the potential for accelerated eutrophication



Distance in Statute Miles to

	Deer Island	East Point	Point Allerton
Site 2	4.0	2.4	5.2
Site 2.5	5.1	2.6	5.5
Site 3	5.8	6.7	2.7
Site 3.5	7.1	5.9	4.9
Site 4	6.6	3.6	6.1
Site 4.5	7.9	4.6	6.9
Site 5	9.4	6.0	8.1

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 7.6-1
RECOMMENDED OUTFALL LOCATION

because of nutrient build-up, and the proximity of these sites to important, extensively utilized resources.

In conclusion, the risk associated with attempting to place an outfall at the shoreward sites is not in the best long-term interest of MWRA. To attempt to fit the outfall into these sites will place a greater burden and reliance on MWRA activities in the area of toxics and nutrient control, and will provide little margin of safety for future changes in water quality requirements. If an extended outfall were ever deemed necessary, the MWRA would incur a significant financial penalty associated with new construction.

The outfall structure should be built as a deep rock tunnel. In all cases, the diffuser, which provides initial mixing of the discharge, should consist of the final 1.25 miles of tunnel, from which 80 riser pipes extend from the tunnel to the sea floor. The underground portion of the diffuser will simply be an extension of the tunnel itself. The riser pipes will be constructed by drilling approximately four-foot-diameter shafts down to the tunnel. Special caps will be provided at the seabed to discharge the effluent into the marine environment.

Section 8

8.0 DETAILED EVALUATION OF THE RECOMMENDED PLAN

8.1 DESCRIPTION OF RECOMMENDED PLAN

As described in Section 7, Evaluation of Outfall Alternatives, it is recommended that the proposed effluent outfall be located in the region bounded by Sites 4.5 and 5.0 (See Figure 7.6-1). A comparison of Sites 4.5 and 5.0 indicates that Site 5.0 offers some additional environmental benefits, but cost considerations favor Site 4.5.

These sites are beyond the sheltering effect of coastal geometry, where there is a significant influence of large-scale Massachusetts Bay processes. Along-shore transport and significant mixing occurs in this area. The tide still dominates at short time scales, and stratification is intense during quiescent periods before being broken down by storm events.

A small degree of sedimentation is evident in these areas, as shown by the presence of bottom sediments during summer months. Field data suggest that winter storms can cause significant resuspension over all water depths. However, the frequency of resuspension decreases with increasing distance (and depth) offshore. Dissolved oxygen (DO) values are generally always near saturation in this region.

The recommended plan for the outfall system consists of a deep rock tunnel and a multi-riser diffuser. The diffuser consists of 80 individual vertical risers equally spaced over a distance of 6,600 ft. A cross-sectional view of the diffuser, which is similar for all sites, is shown in Figure 8.1-1.

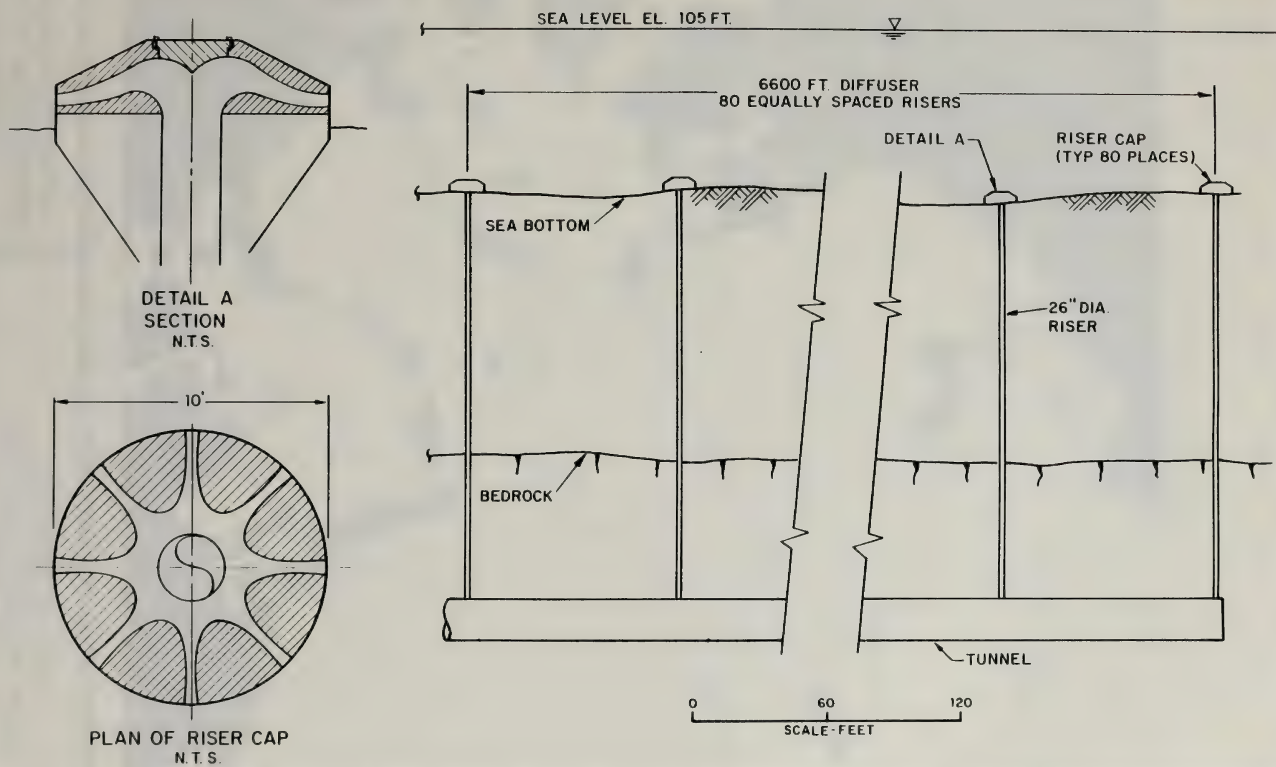
In order to describe the construction within the recommended zone, the outfall systems for Site 4.5 and Site 5 are described below.

8.1.1 OUTFALL SYSTEM TO SITE 4.5

Conceptual Design

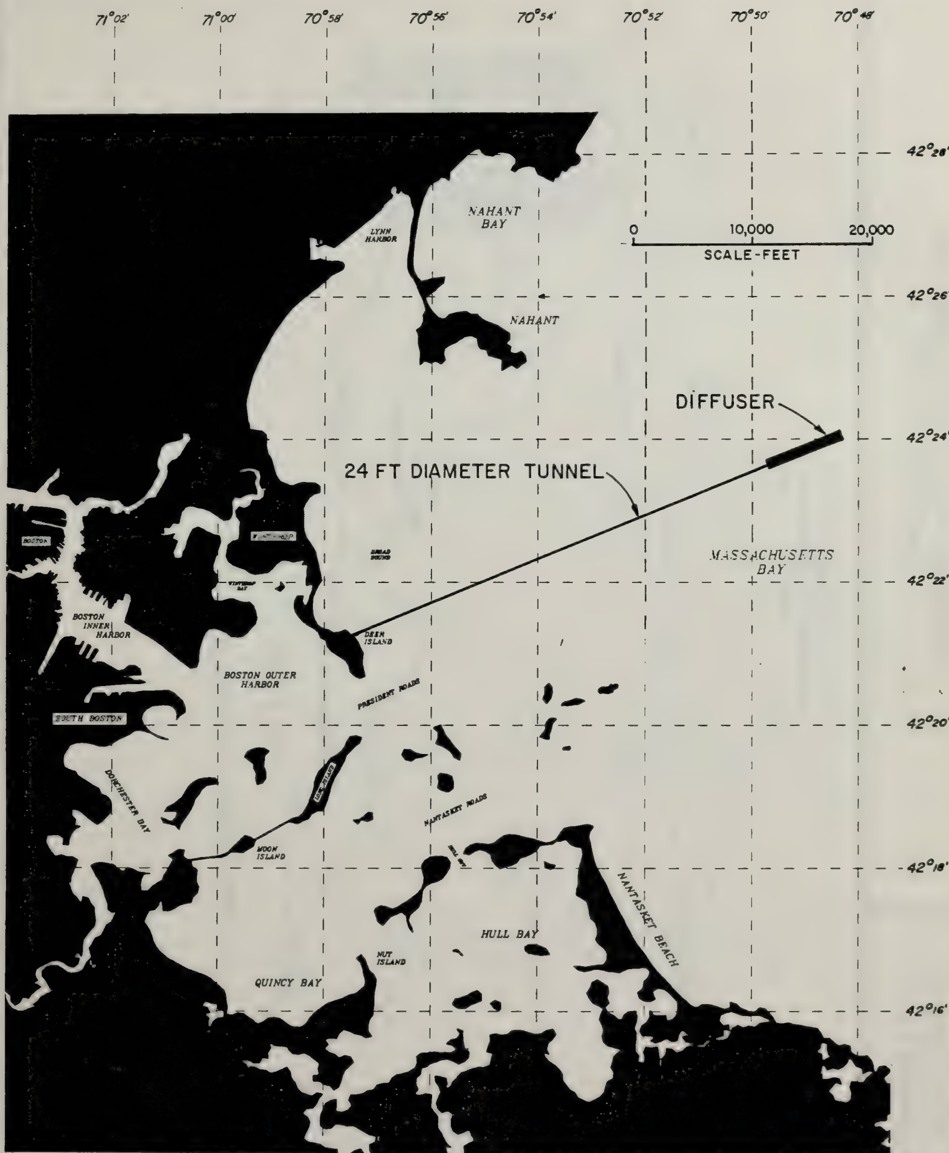
The plan and sections of the proposed outfall system to Site 4.5 are shown in Figures 8.1.1-1 and 8.1.1-2. A minimum 30-ft by 15-ft vertical access shaft will be located on Deer Island. A tunnel lined with concrete with a 24-ft finished inside diameter will be constructed in competent rock approximately 299 to 411 ft below sea level. The tunnel will begin at the bottom of the access shaft and will end below the last diffuser riser. The total length of the tunnel, including the portion below the diffuser, will be 45,000 ft.

The diffuser will consist of 80 vertical risers, with 26-in. inside diameters, equally spaced over the last 6,600 ft of the tunnel. The average riser length from the tunnel to the ocean bottom is 185 ft, at an average depth of 95 ft of water. Each riser will be constructed through soil overburden and rock, and is capped with a multi-port, 10-ft-diameter discharge head at the ocean floor.

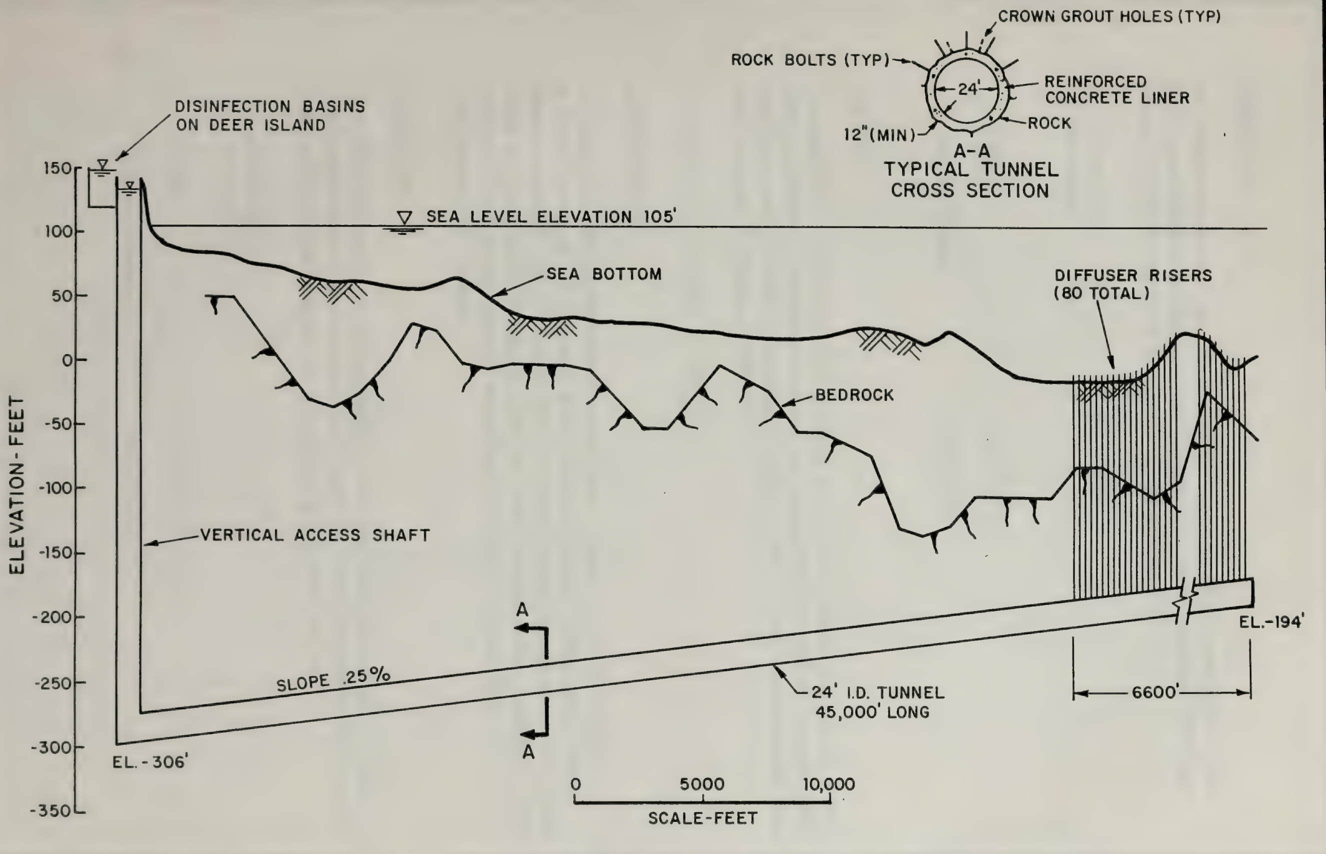


MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8.1-1
DIFFUSER CROSS SECTION



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 8.1.1-1 OUTFALL SYSTEM PLAN SITE 4.5



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8.1.1-2
OUTFALL SYSTEM TO SITE 4.5
TUNNEL - SECTION

Project Costs

The estimated project costs for the outfall system to Site 4.5 are presented below. These project costs represent the estimated capital construction costs in September, 1986, and includes a 35-percent allowance for engineering and contingency costs.

Access Shaft and tunnel	$259,000,00
Diffuser	$129,000,000
Total outfall system	$388,000,000

Schedule

The construction duration, as shown in Figure 8.1.1-3, is 51 months from contract award to system completion. This duration is based on a contract being awarded in the fall of 1990, mobilization over the winter, construction beginning in March, 1991, and the outfall system being completed in December, 1994.

8.1.2 OUTFALL SYSTEM TO SITE 5

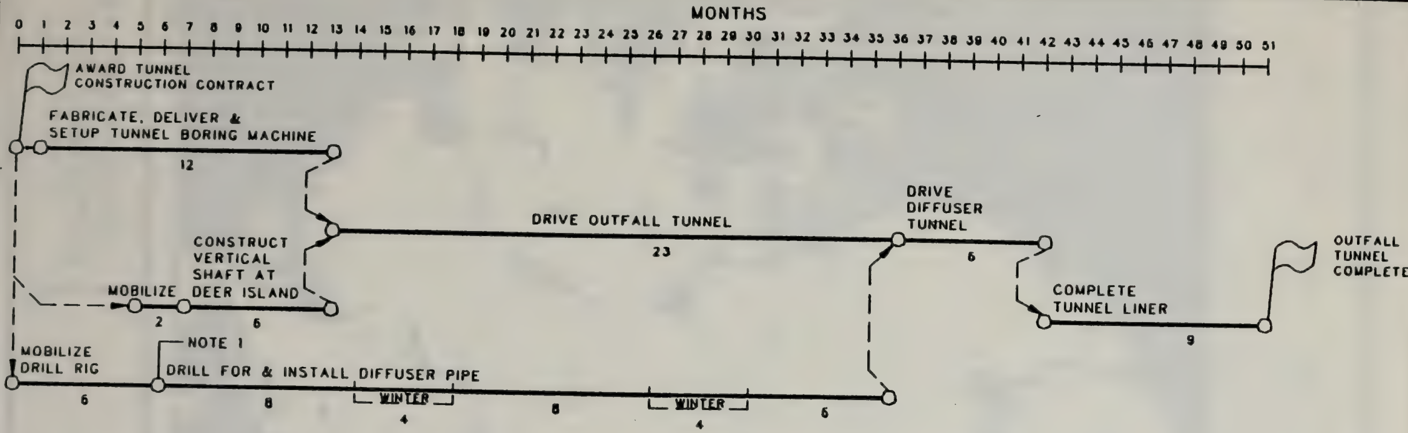
Conceptual Design

The plan and sections of the proposed outfall system to Site 5 are shown in Figures 8.1.2-1 and 8.1.2-2. The tunnel will be similar to that of Site 4.5, except that the inside, finished diameter would be 25 ft; the tunnel will be constructed in rock approximately 355 to 490 ft below sea level. The total length of tunnel, including the portion below the diffuser, will be 54,000 ft. Also, the average riser length from the tunnel to the ocean bottom is 235 ft, in approximately 100 ft of water.

Project Costs

The estimated project costs for the outfall system to Site 5 are presented below. These project costs represent the estimated capital construction costs in September, 1986 dollars, and include a 35-percent allowance for engineering and contingency costs.

Access Shaft and tunnel	$323,000,000
Diffuser	$145,000,000
Total outfall system	$469.000.000



NOTES:

1. SCHEDULE REPRESENTS BEST ESTIMATE BASED ON PRESENT INFORMATION. THERE IS NO SLACK TIME OR CONTINGENCY INCLUDED. ALSO SCHEDULE ASSUMES CONSTRUCTION CONTRACT AWARDED IN THE FALL SO DIFFUSER DRILLING CAN BEGIN IN THE SPRING.
2. SEE FIGURE 3.4-1 FOR THE DESIGN SCHEDULE REQUIRED PRIOR TO CONSTRUCTION.
3. DIFFUSERS

   NUMBER OF RIGS: 2

   NUMBER OF SHIFTS: 2-12 HOUR SHIFTS, 7 DAY WEEK

   NUMBER OF RISERS: 80

   WEATHER DELAYS: 4 MONTH WINTER SHUT DOWN
4. TUNNEL

   NUMBER OF HEADINGS: 1

   NUMBER OF SHIFTS: 4-6 HOUR SHIFTS, 6 DAY WEEK

   TUNNEL ADVANCE RATE: 70 FT PER DAY

   WEATHER DELAYS: NONE

   TUNNEL LENGTH TO DIFFUSER = 38,400

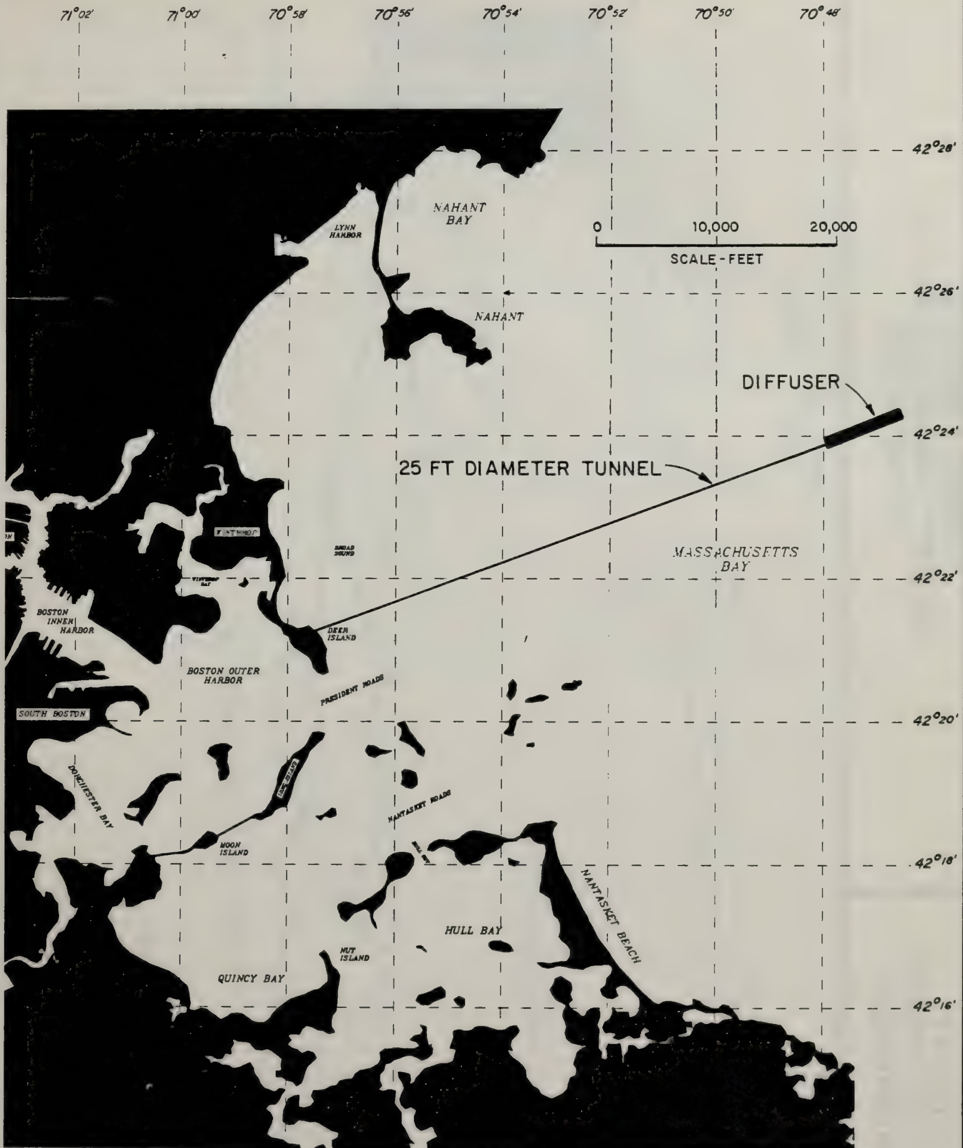
   TUNNEL LENGTH BELOW DIFFUSER = 6,600

   TOTAL TUNNEL LENGTH = 45,000

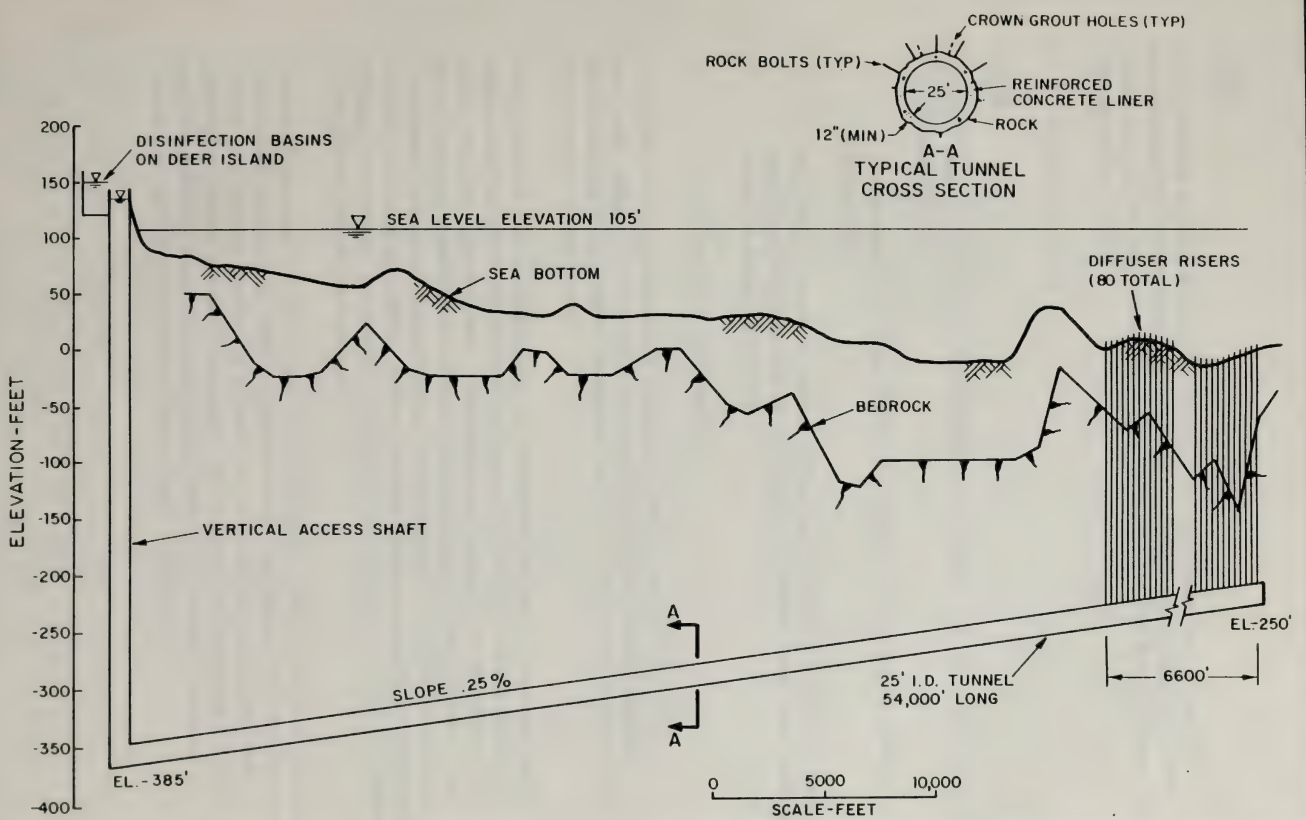
   TUNNEL DIAMETER = 24'

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8.1.1-3
OUTFALL SYSTEM TO SITE 4.5
CONSTRUCTION SCHEDULE



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 8.1.2-1 OUTFALL SYSTEM PLAN SITE 5



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8.1.2-2
OUTFALL SYSTEM TO SITE 5
TUNNEL - SECTION

Schedule

The construction duration, as shown in Figure 8.1.2-3, is 51 months from contract award to system completion. This duration is based on a contract being awarded in the fall of 1990, mobilization over the winter, construction beginning March, 1991, and the outfall system being completed in June, 1995.

8.1.3 CONSTRUCTIBILITY

Tunnel

The outfall tunnel would be constructed beginning at Deer Island. The construction sequence would proceed as follows:

1. Construction of the vertical shaft on Deer Island by excavating from grade down to the tunnel invert.

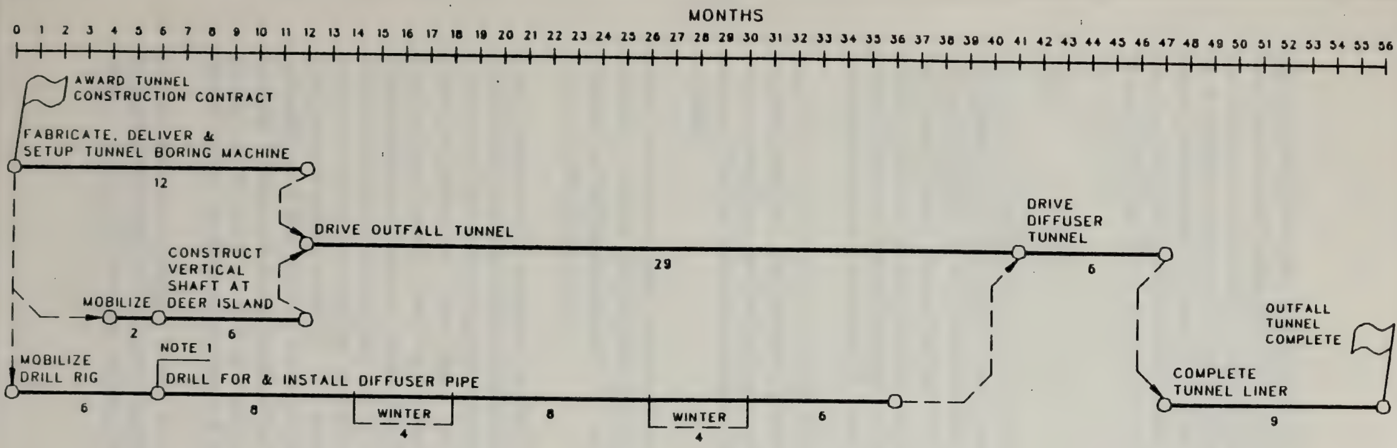
2. Excavation of the outfall tunnel from Deer Island toward the diffuser, removing tunnel spoils from the vertical shaft on Deer Island. The diffuser risers would be complete before the tunnel reaches them.

3. Lining of the tunnel with concrete.

At the proposed vertical shaft location, the geologic profile consists of 80 to 100 ft of glacial soils, mainly in the form of clays or till overlying argillite bedrock. Details of shaft construction can be found in Appendices E and F. Overall construction of this shaft should pose no unusal problems.

Based on current subsurface information, the predominant rock type is Cambridge argillite, a medium-hard rock. Based on information to date on rock strength, hardness, and bedding characteristics, the tunnel excavation should proceed at a moderate rate, estimated at 70 ft per day. It is anticipated that the tunnel will be mined by a tunnel boring machine (TBM), unless detailed field studies conducted during the design phase of the project determine that the nature of the rock along sizable extents of the alignment is not conducive to TBM mining. Although not anticipated, it is possible that some portion of the tunnel may require excavation by conventional drill and blast techniques.

The information available to date on the outer Boston Harbor geology is the result of a series of geophysical surveys, a very limited number of borings, and geological evaluation of bedrock outcrops at a few island locations. It is important to undertake and complete additional geotechnical studies as soon as it is practicable. The impact on the construction schedule could be significant if extensive zones of unusally hard rocks, fractured or weathered material, or rock types not conducive to TBM mining are encountered.



NOTES:

1. SCHEDULE REPRESENTS BEST ESTIMATE BASED ON PRESENT INFORMATION. THERE IS NO SLACK TIME OR CONTINGENCY INCLUDED. ALSO SCHEDULE ASSUMES CONSTRUCTION CONTRACT AWARDED IN THE FALL SO DIFFUSER DRILLING CAN BEGIN IN THE SPRING.

2. SEE FIGURE 3.4-1 FOR THE DESIGN SCHEDULE REQUIRED PRIOR TO CONSTRUCTION.

3. DIFFUSERS

NUMBER OF OFFSHORE RIGS: 2
NUMBER OF SHIFTS: 2-12 HOUR SHIFTS, 7 DAY WEEK
NUMBER OF RISERS: 80
WEATHER DELAYS: 4 MONTH WINTER SHUTDOWN

4. TUNNEL

NUMBER OF HEADINGS: 1
NUMBER OF SHIFTS: 4-6 HOUR SHIFTS, 6 DAY WEEK
TUNNEL ADVANCE RATE: 70 FT PER DAY
WEATHER DELAYS: NONE

TUNNEL LENGTH TO DIFFUSER -	47,400
TUNNEL LENGTH BELOW DIFFUSER -	6,600
TOTAL TUNNEL LENGTH -	54,000

TUNNEL DIAMETER - 25'

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8.1.2-3
OUTFALL SYSTEM TO SITE 5
CONSTRUCTION SCHEDULE

The tunnel will be lined with either precast concrete sections or cast-in-place concrete. The lining will be installed concurrently with the tunnel excavation, following behind the TBM. The concrete lining is included to provide a smooth tunnel wall to minimize the friction head loss in the tunnel, which in turn minimizes the required tunnel size. Final liner design, including thickness and reinforcing, will be based on an evaluation of the internal and external pressures and the load-transfer characteristics of the bedrock. It is assumed that for conceptual design and cost estimating, a 12-inch-thick cast-in-place reinforced concrete liner will be used.

Diffuser

Construction of the diffuser will take place in the open ocean environment. Depending on the final selected site, the diffuser will be located up to 10 miles off the Deer Island shoreline in water depths up to 120 ft. Construction under these conditions can present considerable risk in terms of safety, schedule, and cost. To minimize these risks, the project must be carefully planned and executed. Engineering must be based on a sound knowledge of the subsurface conditions, and the design must be constructible with available offshore construction equipment capable of safe operation under severe ocean conditions.

Geophysical surveys and deep rock borings will be performed to obtain more knowledge of the subsurface conditions. This information is required as input into final site selection within the recommended areas and for final design details such as riser coordinates and invert elevations. The ideal location for construction would be a level ocean bottom with no overburden.

Basically, two different types of offshore rigs are available to the contractor to construct the diffuser. The final selection will be made by the contractor, based on economic conditions existing at the time bids are submitted. The rig could be a jack-up barge or a semi-submersible drilling platform.

Jack-up barge equipment was used as the basis for estimating cost and schedule. This type of equipment was successfully used to construct a similar offshore diffuser at the Seabrook Nuclear Power Station, located approximately 40 miles north of Boston. The jack-up barge must be towed into position over a riser location. The legs are then dropped to the ocean floor, fixing the barge's location. The working platform is then jacked a safe height above the ocean surface to protect it from waves. Construction of the riser is done from the working platform. This procedure must be repeated each time the barge is moved. The estimated duration to install a riser and then move the jack-up barge to the next location should average two weeks during favorable weather conditions. To account for all unfavorable weather conditions, a four-month winter delay has been factored into the schedule. To install 80 risers within a reasonable schedule, two jack-up barges may be used. With proper scheduling, the entire diffuser could be constructed within three good weather seasons, or in approximately 30 calendar months. An additional six months is required for mobilization.

An alternative to jack-up barges is a semi-submersible drilling platform (if available). Semi-submersible rigs are self-propelled floating platforms held in position by anchor settings. These rigs do not rest on the ocean bottom; however, their working platforms are

located a safe height above the ocean surface. Several types of these rigs exist, including the AKER H-3 (Modified), built by Aker Engineering A/S of Oslo, Norway. The rig could work throughout the year off the Massachusetts coast, and could install one diffuser every 1 to 1.5 weeks. It is estimated that the entire 80-riser diffuser could be installed in 20 to 30 calendar months. An additional six months is required for mobilization.

8.1.4 SUMMARY

The recommended outfall system to Sites 4.5 or 5 includes a vertical access shaft located on Deer Island, a deep rock tunnel, and a diffuser consisting of 80 individual vertical risers, equally spaced over a distance of 6,600 ft.

July, 1994 is the present court-ordered completion date for the outfall system. This date was based on the new outfall being located approximately 3.5 miles from Deer Island. The two sites being considered require tunnel lengths between 45,000 ft (8.5 miles) and 54,000 ft (10.2 miles). Also, the diffuser is larger and must be constructed in deeper water than originally anticipated. These factors result in estimated outfall system completion dates ranging from December, 1994 to May, 1995, depending on the site. To support these completion dates, engineering work should begin in January 1988.

8.2 CONSTRUCTION-RELATED IMPACTS

This section addresses the effects of construction of the effluent tunnel and outfall diffuser on marine biota. Potential impacts from habitat removal, increases in turbidity, resuspension of sediments, and disposal of excavated materials are considered. The analysis contained herein is preliminary, since not all of the data necessary for the assessment are currently available.

8.2.1 EFFLUENT TUNNEL

Construction of an outfall tunnel 7.9 - 9.4 miles long and 24 - 25 ft in diameter will have essentially no adverse long-term impact on the marine environment. An estimated 1.4 - 1.86 million yd^3 of material will result from tunnel boring operations.

At the present time, plans for either the use of excavated tunnel spoil, or its disposal, have not been finalized. Studies are currently underway that will determine the feasibility for using the tunnel spoils is aggregate for low-strength concrete. Another option, which would provide for constructive use of tunnel spoils would be to provide spoils for use by the Third Harbor Tunnel project, as backfill material. If either of these options are determined not to be feasible, the excess tunnel spoils would be disposed of, or used as backfill at areas other than Deer Island.

8.2.2 DIFFUSER STRUCTURE

Construction of the 1.25 mile-long diffuser for the effluent tunnel will result in several impacts to the marine community. Drilling and excavation for the risers will result in habitat removal, increase in ambient turbidity, resuspension of bottom sediments, and will require disposal of excavated material.

Habitat Removal

Riser construction will consist of sinking shafts via two drilling rigs deployed from jack-up barges as described in Section 8.1.3. The current conceptual diffuser design will require approximately 80 risers, each consisting of a 4-ft-diameter borehold. Approximately 12,000 yd^3 of material will be excavated for the risers. Excavated sediment will be disposed of at the Corps of Engineers designated Foul Area. Excavated material from rock drilling would be disposed of or will be used along with the materials excavated from construction of the tunnel.

Benthic Community

The adverse impact of riser construction on the benthic community is expected to be minimal. An estimated 2,260 ft^2 of benthic habitat would be permanently removed during the drilling for riser placements. This would occur over a two-and-one-half to three-year period. Appendix B provides a detailed description of the benthic community in the study area. The heterogeneity of bottom types within Massachusetts Bay suggests that the diffuser risers will traverse both soft-bottom and hard-bottom habitats, affecting both infaunal and epifaunal communities in those areas. The benthic communities in the vicinity of the recommended diffuser area are non-stressed, with very high species diversity.

Given the availability of similar, unaffected, and heterogeneous habitats that characterize Massachusetts Bay, there should be no long-term effect on local populations of benthic organisms as a result of diffuser construction. It is expected that recolonization of the area by similar species to pre-existing levels will occur, following a suitable period of time. Short-term changes in species composition are expected, however, since opportunistic, pioneer species normally associated with stressed environments are generally the first to recolonize an area after a disturbance. Benthic infaunal assemblages along the diffuser should resemble existing communities over the long term.

Fish and Shellfish

The recommended outfall area appears to be variable with respect to availability of fish and epibenthic shellfish. Site 4.5 was highly diverse and productive with respect to fish and epibenthic shellfish, based on results of the field sampling program. Site 5, on the other hand, was relatively unproductive in terms of fish and epibenthic shellfish.

Impact of diffuser construction on fish and epibenthic shellfish is expected to be short-term and related to the temporary loss of bottom habitat, increased turbidity, and resuspension of bottom sediments. With respect to the commercially valuable demersal fish (e.g., flounder), no appreciable loss of spawning or nursery habitat is anticipated as a result of riser placement. Information obtained from the Massachusetts Division of Marine Fisheries (MDMF) indicates that the outfall area provides habitat for yearling haddock and cod, and appears to be a nursery area for butterfish and longfin squid as well. Drilling for riser placement may adversely affect some of these species, particularly if construction occurs during their spawning periods.

Construction of the risers, which is expected to take approximately 3 years, should not impose an economic loss on commercial dragging activities, since fishermen cannot readily use this area because of lack of towable bottom and conflict with lobster gear. The local demersal fish populations may even benefit marginally from the fishing hiatus. Status-of-the-stocks data indicate that stock biomass has been steadily declining for the majority of the commercially-sought species, and that fishing mortality is well-above the maximum sustainable yield for these species. Over-exploitation, coupled with poor recruitment in recent years, has severely stressed commercially important species.

Lobsters appear to be moderately abundant in the outfall area. They are generally more abundant inshore in the spring, and move offshore in the fall, (MDMF, 1987). Construction of the risers for the diffuser will adversely affect these organisms through loss of habitat. However, the temporary loss of habitat should not be significant. During riser construction, lobstermen will be able to continue fishing within the site area, although they will not be able to set pots across the construction area. Riser placement, therefore, should not result in any appreciable economic loss to this industry.

Turbidity

Increased turbidity associated with drilling operations has the potential for adversely affecting organisms such as phytoplankton, by interfering with physiological processes. Phytoplankton can be directly affected by reducing the amount of sunlight penetrating the euphotic zone. This "shading effect" can reduce primary productivity and lower the biomass and standing crop, which may in turn limit zooplankton and species at other trophic levels that depend on the plankton stocks. Such shading will generally be short-lived, because most suspended sediments will settle out within 24 hours. At Site 4.5 (the only soft-bottom site within the outfall area), it is anticipated that drilling will not result in excessive increased turbidity as a result of resuspension of these materials, since the larger grain sizes of silty-sand with gravel will settle out rapidly.

Resuspension of Bottom Sediments

Drilling operations have the potential for resuspending bottom sediments. Chemical constituents of the resuspended sediments, including contaminants such as metals, have the potential to impact the water column. Bulk sediment chemistry analysis of the sediments within the study area indicate that, with respect to polynuclear aromatic hydrocarbons (PAHs), concentrations in the surficial sediments are quite variable. At Site 4.5, concentrations of total PAHs ranged from 0.00 to 6.97 μg/g. Total PAH concentrations in marine sediments at the recommended site show lower contamination levels than sediments closer to or within the Harbor. With respect to metals, sediment concentrations at Site 4.5 were generally below levels from Deer Island or Nut Island sediments. Similar sediment samples have been determined to be acceptable for offshore spoiling, based on Massachusetts Standards for Classification of dredge spoil (314 CMR 9.03). In bioassay studies and bioaccumulation studies, these sediments have been shown to be non-deleterious to marine life (refer to Section 7.5 of the Inter-Island Transport Report, Volume VI). Thus, resuspension of metals and organics in sediments from Site 4.5 as a result of drilling for the diffuser risers should not have a deleterious impact on local marine biota.

At Site 5.0, there are essentially no surficial sediments, since this is a hard-bottom area with dispersive natures. Thus, drilling for riser placement should not have a deleterious effect on local biota in terms of resuspension of toxic materials.

Disposal of Excavated/Dredged Material

It is estimated that approximately 12,000 yd^3 of material will be excavated for the diffuser risers. Options for disposal of this material include offshore disposal at the Corps of Engineers Foul Area Disposal Site (FADS) in Massachusetts Bay.

In the event that offshore disposal is adopted, the material would be suitable for disposal at FADS in terms of the levels of contaminants present within the surficial sediments. With respect to the potential impact, benthic infaunal communities at the FADS would be lost primarily through burial. Density and biomass of benthic infaunal species at the FADS is high to moderate when compared to other areas within Massachusetts Bay, indicating that recolonization by early successional infaunal species (e.g., opportunistic, pioneer species indicative of stressed communities) occurs readily upon completion of the disturbance. It would therefore be expected that recolonization of benthic infauna at FADS will occur after disposal of drilling/dredge material has been completed.

8.3 OPERATION-RELATED IMPACTS

This section addresses the effects of operation of both the primary (1995-1999) and secondary (1999-on) wastewater discharges on the marine environment. Potential impacts to marine biota from the wastewater discharge may result from changes to water quality/chemistry, from sedimentation, and because of nutrient loading. Each of these potential impacts are evaluated herein. However, it should be recognized that this analysis is preliminary, since not all of the field data being acquired through the STFP program are presently available. A more comprehensive impact assessment will be provided in the final STFP.

8.3.1 PRIMARY EFFLUENT (1995-1999)

Water Quality - Conventional Constituents

The discharge of primary effluent is not expected to have an appreciable impact on water quality in the area of the diffuser. Water quality parameters such as pH and temperature will not be substantially altered as a result of the discharge. The DO levels, while reduced, will be above the state standard of 6 mg/l. This assessment is based on the characteristics of the influent and predicted effluent quality. Massachusetts Water Quality Standards will be met for pH, temperature, and coliform bacteria at the edge of the mixing zone.

Within the outfall area, the water column was well-oxygenated, and there was no evidence that inadequate ventilation and/or excessive oxygen utilization was occuring that favored an oxygen deficit or anoxic conditions. At the outer-end recommended site, DO is predicted to always be in excess of saturation, even under worst-case conditions (e.g. summer stratification).
DO predictions for Site 4, assumed here to be a conservative indication of Site 4 (part of the

recommended outfall area), indicate a DO deficit ranging from no deficit to a deficit of 1.5 mg/l. Violation of the DO Standard based on conditions predicted at Site 4.0 are therefore possible, but would be infrequent. The design of the outfall diffuser should also minimize the potential for oxygen deficits within the edge of the mixing zone, since the plume will entrain bottom water and create artificial upwelling conditions, ensuring adequate mixing in the water column.

Oxygen deficits are unlikely to occur as a result of excessive algal production resulting from nutrient loading. In the event that an algal bloom occurs, DO produced through the photosynthetic process may be offset by respiration requirements and may, in fact, lead to oxygen deficits. However, such an occurrence would be of short duration, and in the face of adequate mixing within the open coastal environment, of little consequence.

The presence of the risers will add some structural complexity to the bottom habitat and will attract fish and mobile invertebrates to the area of the diffuser. This attraction is common at offshore structures, and the risers will function, in effect, as artificial reefs. The structures will also provide additional habitat for epifaunal communities. Benthic species likely to be attracted to bottom structures include cunner, hake, ocean pout, and lobster. Other, less habitat-dependent species, such as flounder, may also be attracted to the area as a result of an increase in food sources.

Water Quality - Non-Conventional Constituents

Impact evaluation of the four-year (1995-1999) discharge of constituents within the primary effluent on marine biota includes consideration of both short-term (acute) and long-term (chronic) effects of non-conventional constituents.

The discharge of primary effluent, containing a total of 26 trace metals and organic compounds including PAHs, PCBs, and chlorinated pesticides, was modeled, as discussed in Appendix A. Modeling of the primary effluent discharge was performed to evaluate compliance with EPA "Gold Book" (1986) criteria at the edge of the mixing zone. These criteria are referred to as the Criteria Maximum Concentration (CMC), for evaluation of acute effects to marine organisms, and Criteria Continuous Concentration (CCC), for evaluating chronic effects to marine organisms. The CMC is a concentration not to be exceeded by a one-day average more than once in three years. The CCC is a concentration not to be exceeded by a four-day (consecutive) average more than once in three years.

Modeling, which represented worst-case conditions based on the results of a joint frequency distribution analysis, used ambient water quality concentrations, contaminants from other sources, including wastewater discharges at Lynn, South Essex, and from MDC CSOs, and concentrations of the constituents resulting from a buildup during worst-case hydrological conditions.

For initial dilution, a stepwise procedure was used to predict concentrations. This initial dilution corresponded to a frequency of occurence of one day in 342 years. From this analysis, concentrations at the edge of the mixing zone were compared with EPA criteria for protection of marine organisms. Within the mixing zone, the potential for adverse impact is considerably

reduced, since the residence time of non-conventional constituents in the near-field is approximately 10 minutes. The mixing zone encompasses only a relatively small area on either side of the diffuser.

The results of this analysis indicated that the concentrations of all modeled constituents were less than the CMC (acute) values at the mixing zone. Four modeled constituents exceed the CCC (chronic) criteria at the edge of the mixing zone: PCBs, mercury, heptachlor, and 4,4-DDT. The results of these worst-case analyses for each of the four constituents are compared with ambient water column concentrations (where available), background modeled concentrations, the CCC, and a modeled annual average condition, in Figures 8.3.1-1 through 8.3.1-4.

A description of water chemistry impacts to marine biota is provided below for these four constituents. Ambient receiving-water PCB concentrations are currently in excess of the Gold Book, CCC criterion. For mercury, heptachlor and 4,4'-DDT, considerations for a source control strategy, implemented through industrial pretreatment or nonindustrial source control are recommended to establish compliance with the CCC criteria.

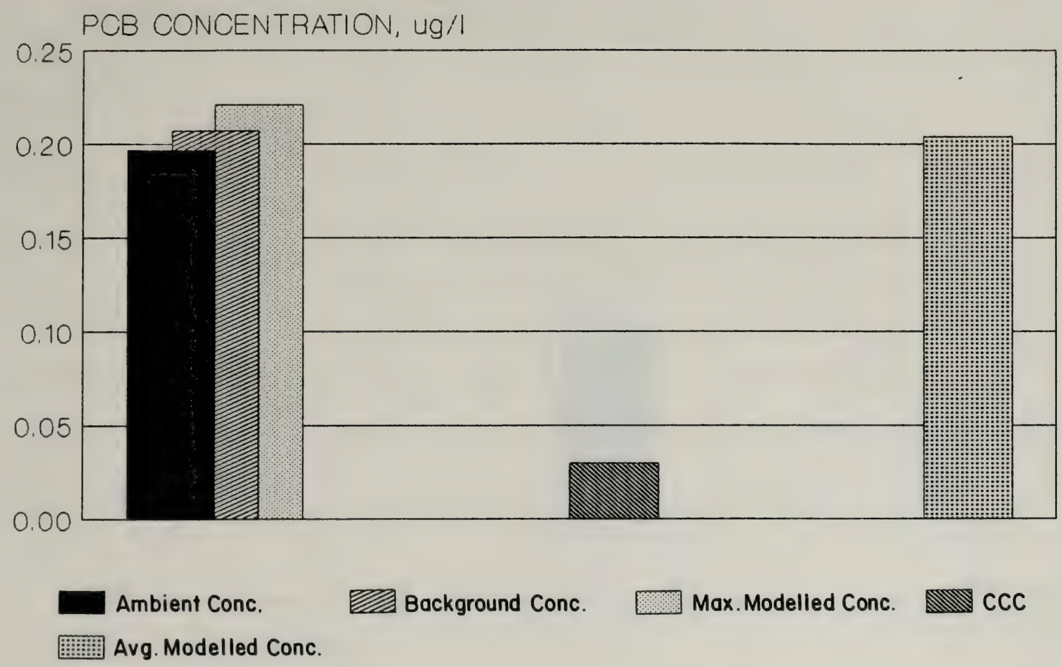
PCBs

Polychlorinated biphenyls are present in the ambient water column in levels already exceeding the EPA CCC value of 0.03 μg/l. Ambient PCB concentrations were found to be 0.197 μg/l. The MWRA (Deer Island) contribution to PCBs was projected to be 0.020 μg/l for a total predicted maximum concentration of 0.217 μg/l. This value is approximately 86 percent higher than the CCC. Average PCB concentrations at the edge of the mixing zone are predicted to be about 0.204 μg/l, which is well above the CCC value. Ambient concentrations comprise 90 to 95 percent of the modeled total.

Since PCBs are readily adsorbed by the sediments, the pathway to marine organisms is generally through the sediments rather than the water column. Thus, water column values, although above the CCC, are not expected to be directly detrimental to marine biota. However, additional PCB loading in the water column will result in increased deposition of PCBs in sediments.

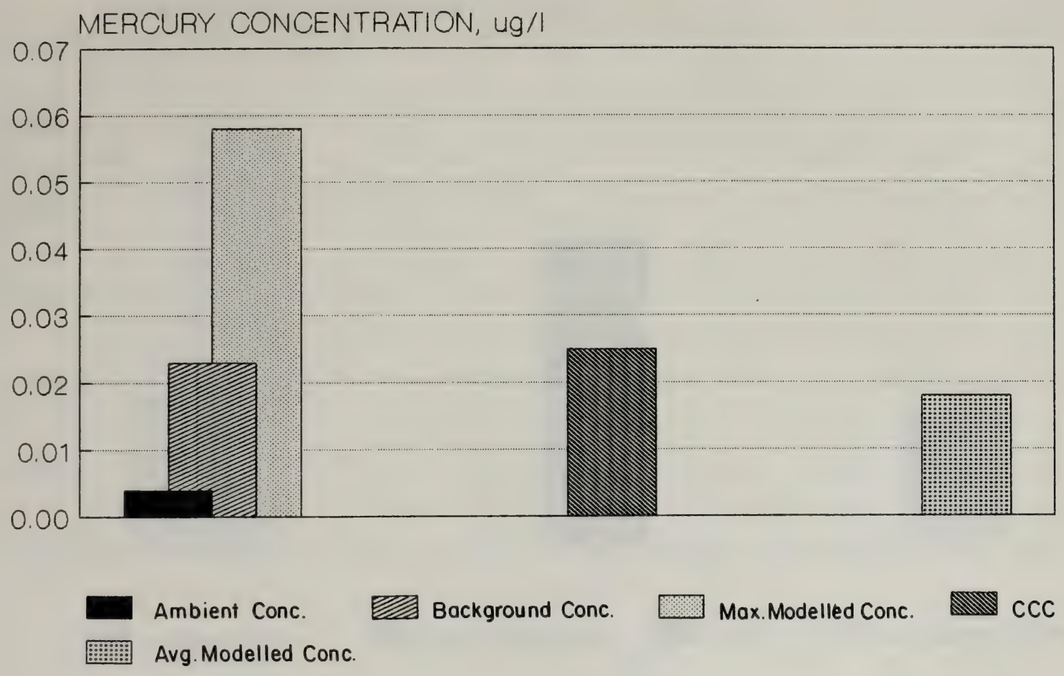
Data collected by the Massachusetts Division of Marine Fisheries indicate that PCBs in Boston Harbor sediments are contributing significantly to higher body burdens for lobster and flounder in inshore areas.

The effects of PCBs contained within the primary effluent and discharged to the coastal marine environment are non-quantifiable. Certainly, the high ambient concentration of PCBs has the greatest significance in this evaluation. The MWRA contribution is small when compared to existing background levels. It is therefore clear that reduction in ambient PCB levels is necessary to establish compliance with the CCC criteria for protection of marine life. Future actions such as the elimination of the discharge of sewage sludge will reduce ambient water column and sediment burdens of PCBs, and will help bring effluent concentrations more in line with the EPA Water Quality Criteria. Until that time, further introduction, of any amount of PCBs into the marine environment, will add to the sediment burdens and result in potential adverse impact to marine biota.



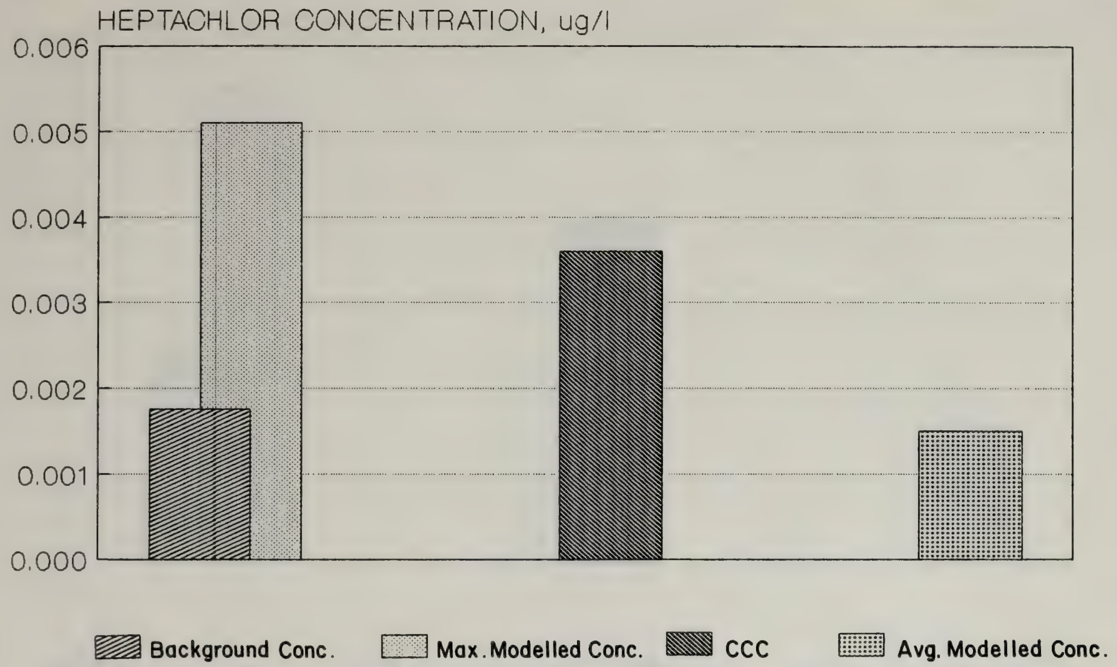
MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8.3.1-1
COMPARISON WITH EPA WATER QUALITY CRITERIA - PCBs



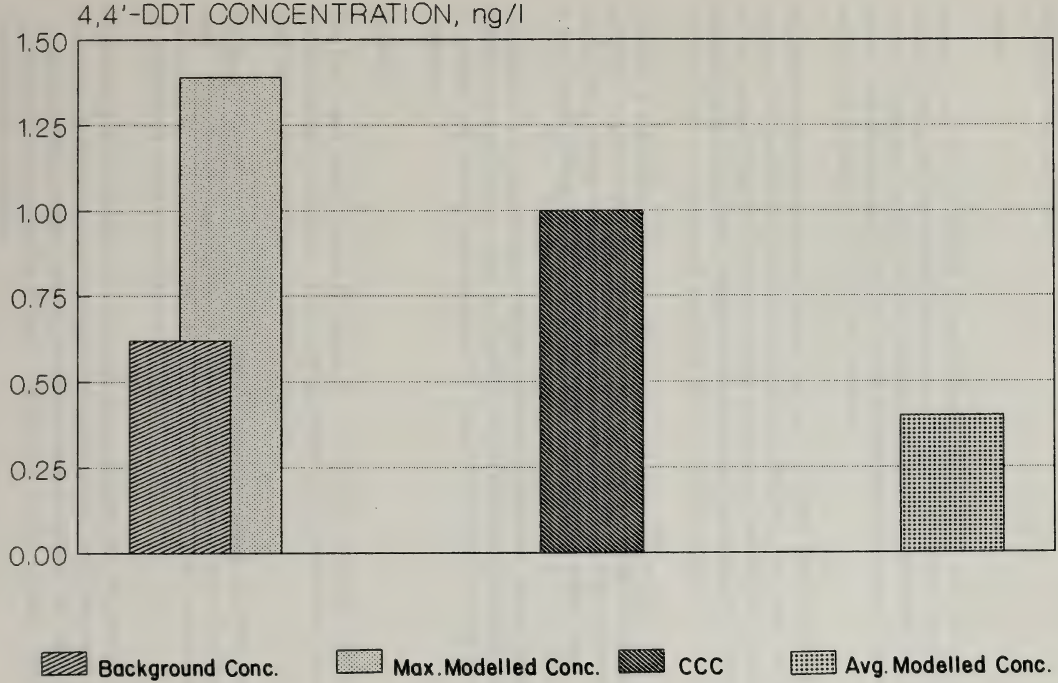
MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 8.3.1-2
COMPARISON WITH EPA WATER QUALITY CRITERIA - MERCURY



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 8.3.1-3
COMPARISON WITH EPA WATER QUALITY
CRITERIA - HEPTACHLOR



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 8.3.1-4
COMPARISON WITH EPA WATER QUALITY
CRITERIA - 4,4-DDT

The potential for negative impact is reduced because of the dispersive nature of the habitat. Thus, PCBs or other contaminants contained within the primary effluent are not likely to be deposited in the outfall area, but rather will be dispersed and carried off to be deposited in some other offshore locations.

Mercury

Mercury, particularly in the form of methylmercury, has shown to be highly toxic to fish and wildlife. Data on the acute toxicity of mercuric chloride are available for 29 genera of saltwater organisms, including annelids, molluscs, crustaceans, echinoderms, and fish. In general, fish tend to be more resistant to the acute toxic effects of mercuric chloride, while molluscs and crustaceans tend to be more sensitive.

The derivation of the water quality criterion for mercury is more complex than for most metals because of the potential for methylation of mercury in sediments, fish, and in the food chain of fish. Almost all mercury is currently being discharged as mercuric ion. The best available data concerning the long-term exposure of fish to mercuric ion indicates that concentrations above 0.23 μg/l cause statistically significant effects on the fathead minnow.

The EPA Water Quality Criteria for mercury are 2.1 μg/l (CMC) and 0.025 μg/l (CCC) for acute and chronic exposure, respectively. The predicted maximum concentration of mercury at the edge of the mixing zone is 0.093 μg/l. This value exceeds the CCC by about 73 percent, thus the CMC is not violated. Effects, if any, will therefore be confined to the sublethal levels.

Average mercury concentrations at the edge of the mixing zone are predicted to be 0.018 μg/l, well below the CCC value. Thus, it is unlikely that the short-term event will adversely impact local biota, and mercury concentrations within the primary effluent should be of no long-term consequence.

Heptachlor

The EPA Water Quality Criteria for heptachlor are 0.053 μg/l and 0.0036 μg/l for acute and chronic exposure, respectively. The 0.0036 μg/l value is a 24-hour average, while the 0.053 μg/l concentration should not be exceeded at any time.

Predicted maximum concentrations of heptachlor within the mixing zone were modeled to be 0.0053 μg/l. Thus, modeled concentrations of heptachlor within the mixing zone are in violation of the CCC by about 32 percent. Since the acute toxicity (CMC) value is not exceeded, any effects on marine biota would be at the sublethal level.

Heptachlor has been demonstrated to be highly toxic to aquatic life, to persist for long periods in the environment (e.g. does not readily biodegrade), and to bioconcentrate in organisms at various trophic levels. Little information is available on the pathways to marine organisms and the physiological effects (e.g. impairment of reproduction), as the result of exposure to this insecticide.

Heptachlor tends to persist in the water column, partitioning about 81 percent in the water, and 17 percent as settleables. The potential impact to marine organisms would, thus, appear to be through the water column. Since the acute toxicity value is not violated, short-term impacts are unlikely. Chronic exposure to sublethal doses of heptachlor are unlikely, since the predicted average concentrations within the mixing zone are below the CCC (0.0015 μg/l). The one-time occurrence described here is unlikely to have a significant impact on local populations of marine organisms.

4,4-DDT.

During worst-case conditions, the modeled maximum concentrations for 4,4-DDT at the edge of the mixing zone is predicted to be 0.00195 μg/l. This value is well below the CMC of 0.130 μg/l. The predicted concentration of 4,4-DDT at the edge of the mixing zone for comparison to the CCC is 0.00139 μg/l, which is in excess of the CCC of 0.001 μg/l by 39 percent.

Average concentrations within the mixing zone are predicted to be 0.0004 μg/l, well below the CCC. Therefore, adverse impact to local biota, if any, would be confined to a small area (the mixing zone) for a short period of time.

Summary

Overall, the effects of the primary effluent on water chemistry and marine biota should not be substantial. Within the mixing zone, violations of the CCCs for these substances do occur, however, the mixing zone represents a very small area, and residence time of constituents within the mixing zone is approximately 10 minutes. Far-field concentrations of these constituents will be significantly less. With the exception of PCBs, all constituents pass the CCCs under predicted average conditions. Thus, no long-term deleterious impact to marine biota is anticipated.

Plankton and Primary Productivity

The discharge of a primary effluent from 1995-1999 at the recommended outfall area has a potential to cause increased phytoplankton productivity within the study area. Based on the results of field and laboratory testing, primary productivity rates in the vicinity of the proposed outfall during the summer sampling period were generally low and stable. The results of the study are described in Appendix B.

Nutrient-spike experiments indicated that the effects of increased ammonia, phosphate, and silica stimulated carbon production rates, chlorophyll biomass yield, and species growth rates in receiving water. However, enrichment did not trigger blooms of nuisance species or algal groups during the experimental period. Community structure also generally remained intact. The most abundant phytoplankton species tended to increase their predominance upon enrichment, which favored the diatoms. Blooms of these species are not generally associated with nuisance conditions.

The proposed outfall area, because of its oligotrophic nature, appears best able to cope with nutrient loading accompanying the wastewater discharge. However, the nutrient-spike experiments evaluated the effects of short-term initial exposure, during which nutrient concentrations rapidly decreased due to utilization by phytoplankton. Within the approximate four-year period when primary effluent would be discharged, a continuous exposure to enrichment would exist. Thus, although operation of the wastewater outfall at the proposed location appears to cause limited adverse impact on phytoplankton processes and ecosystem functioning, the effects of long-term nutrient loading to the system are not known at the time of this writing.

With the constant nutrient source available, the oligotrophic, diatom-dominated phytoplankton community could potentially be stimulated to productivity levels far in excess of those presently observed, but the extent to which excessive algal production may occur cannot be quantified at this time. Also, changes in species composition may potentially occur over a period of time. More detailed nutrient and productivity studies may be necessary to determine the full extent of these potential impacts.

Effects on Benthos

Bottom-dwelling (benthic) organisms may be directly affected by operation of the wastewater discharge through sedimentation. This would result in the deposition of material leading to burial, or indirectly through the accumulation of contaminants in the regional sediments. Both of these potential impacts are discussed herein. At the present time, this analysis is preliminary; the results of bioaccumulation tests, and evaluation of additional data will be included in the final version of this document.

Sedimentation

Sedimentation rates were modeled to evaluate the effects of the proposed outfall for both primary and secondary effluents, as described in Appendix A. A mass rate of 1150 g/sec for total suspended solids was used in the sedimentation analysis, which was based on a weighted average for the treatment facility flow rates during high and low groundwater conditions. Two settling velocities, 0.01 cm/sec and 0.001 cm/sec were used in the analysis to cover the range of anticipated settling velocities.

The recommended outfall area was modeled to have the lowest maximum sedimentation rates for both the primary and secondary effluents. Predicted maximum rates at the recommended outfall area were between 0.20 g/m^2/day and 1.39 g/m^2/day. These translate to a maximum total deposition of between 73 and 511 g/m^2/year, assuming all material eventually settles out, without resuspension. Thus the maximum sedimentation rate would produce a little over one pound of settleable material per square meter, or about 0.5 millimeters per square meter each year.

Nichols et al. (1978) conducted in situ experiments on the burial of marine invertebrates in Buzzards Bay. Various thicknesses of sediment were used to cover the bottom and its natural faunal assemblages. Most species common to the soft-bottom community could escape

instantaneous burial of 5 to 10 cm, but at depths of 30 cm, none of the organisms even attempted escape. Nichols et al. (1978) determined that organisms could escape burial to a depth of 28 cm.

Given the limited deposition resulting from the primary effluent, mortality of benthic organisms as a result of burial is improbable.

Bioaccumulation

It is generally accepted that toxic materials bioaccumulate more readily in marine organisms through sediment pathways than through the water column. The sediments are the ultimate sink for pollutants such as PAHs, PCBs, and trace metals. Concentrations of metals and organic compounds in sediments have been shown to be correlated with grain size and total organic carbon (TOC). Thus, constituents within the primary effluent have the potential to accumulate in sediments, particularly sediments high in silt and clay or total organic carbon.

Bioaccumulation factors for some metals are available for a few marine species. But generally, these factors are inappropriate for impact assessment since baseline conditions are unknown. Thus the assessment of the potential for bioaccumulation relies essentially on the characteristics of the benthic environment in the vicinity of the outfall and the species inhabiting these habitats. However, it is assumed that there is a potential for accumulation of pollutants.

The proposed outfall area has been deemed a dispersive environment. This suggests that contaminants will not be deposited in the area. The non-stressed benthic communities are also better able to withstand perturbations from the wastewater discharge, as indicated by the high species diversity indices. Thus, overall, the potential for bioaccumulation of toxic materials in the benthic community is considered to be small, given the nature of the environment. Ultimately, contaminants discharged within the effluent will find their way to soft-bottom substrates, most characteristically, to sediments with high silt and clay. However, further studies would be necessary to determine the fate and transport of these materials beyond the study area.

Fisheries

Trawl and gill net collections in the outfall area suggested a diverse community of demersal fish and shellfish at Site 4.5. This included a mixture of those species normally found on sandy bottoms, such as winter flounder and American plaice, and those more normally occurring on hard bottoms, such as cunner, ocean pout, searobins, and various hakes. Fish sampling at Site 5.0 did not yield any fish or shellfish, however, Site 5.0 is a hard-bottom site which would be expected to yield more typical hard-bottom species. The limited field data collections that are part of this project do not necessarily represent a comprehensive description of the abundance of species in the outfall area. Review of the Massachusetts DMF trawl data was conducted to provide a general description of the typical species composition and relative abundance at the outfall area.

The discharge of primary effluent in the outfall area (Sites 4.5 and 5.0) is not expected to have adverse impacts on either local fisheries resources or commercial fishing activities. Moving the discharge site from the present location in Boston Harbor to the offshore outfall area is expected to produce positive long-term effects on local fisheries. Basically, the offshore outfall area:

- avoids the most important commercial lobster fishing areas.
- limits impacts on the inshore recreational fishery.
- protects nearshore fish spawning areas and clam beds.
- reduces the potential for bioaccumulation.
- permits pelagic species to avoid the discharge plume.

As described previously, the presence of the risers will add some structural complexity to the bottom habitat and will attract fish and mobile invertebrates to the area of the diffuser.

Resource Protection

The outfall area consists of predominantly hard-bottom and coarse-grain sand and gravel substrate. The absence of soft-bottom sediment reduces the potential for accumulation of contaminants in the sediment. Since sediment (with high silt and clay fractions or total organic carbon) is the primary pathway for bioaccumulation into the marine food chain, the outfall area is not expected to have adverse bioaccumulation impacts.

The offshore open water location of the outfall area discharge plume will not serve as a barrier to pelagic species and will permit migratory species such as herring, alewives, and smelt to avoid the plume. Circulation patterns and dilution factors at the outfall area are not expected to cause adverse discharge impacts on the nearshore spawning grounds for flounder and other species. The protection of this habitat may have a positive influence on future fishery stocks and harvests. Similarly, the effective isolation of the outfall area from the nearshore environment is expected to protect nearshore clam beds; the elimination of nearshore discharges may result in the natural improvement in the quality of these nearshore beds.

8.3.2 SECONDARY EFFLUENT (1999+)

The assessment of impacts to the marine ecosystem from discharge of a secondary effluent beginning in the year 1999 is provided in this section. It should be recognized that there are limitations in attempting to predict the effects of a discharge in 1999, due to the fact that the existing biological and chemical oceanographic conditions within the proposed outfall area in 1999 may be different from present day conditions. This would be true not only as a result of the operation of a primary effluent for five years, but also because of normal successional changes in community structure and dynamics. The approach here is to compare the impacts associated with a secondary effluent to those projected for the primary effluent. This assessment will indicate an increased or decreased potential for impact to the marine ecosystem as a result of a secondary wastewater discharge at the proposed location.

Water Quality - Conventional Constituents

The discharge of the secondary effluent is not expected to have an appreciable impact on water quality in the area of the diffuser. Water quality parameters such as pH, temperature, and DO will not be substantially altered. At the edge of the mixing zone, all Massachusetts Water Quality Standards will be met.

DO deficits are not anticipated. The secondary effluent will contain a greater proportion of ammonia (with a commensurate decrease in organic nitrogen) and less phosphate than the primary effluent. This may increase the potential for stimulating algal production because, while phosphate does not, at this time, limit primary productivity, ammonia may be the limiting factor. In the face of increased oxygen demand associated with the residual effect of an algae bloom, there is the potential to lead to oxygen deficits. However, as in the case of the primary effluent, such an occurrence would generally be of short duration and, with adequate mixing in the open coastal environment, of little consequence.

Water Quality - Non-Conventional Constituents

For the secondary effluent, the predicted concentrations of all modeled effluent constituents were determined to be lower than the CMC at the ZID. As described in Appendix A, only one non-conventional secondary effluent constituent, PCB's was predicted to exceed the CCC (chronic) criterion at the edge of the mixing zone.

PCBs

The total maximum predicted concentration of PCBs at the edge of the mixing zone were modeled to be 0.198 μg/l. The ambient PCB concentration was 0.197 μg/l. As in the case of the primary effluent, average predicted concentrations at the edge of the mixing zone are still above the CCC (.198 μg/l), due to the high ambient conditions.

Since MWRA's contribution to the predicted PCB concentration is so small (about 3 percent), it is clear that reduction of ambient levels is necessary to ensure adequate protection for the marine environment.

At the proposed MWRA outfall area, the potential for adverse impact to local biota from the secondary discharge is considered to be very small, for the reasons noted in Section 8.3.1 primary effluent.

Plankton and Primary Productivity

The discharge of a secondary effluent at the proposed outfall location is believed to have a greater potential for affecting phytoplankton productivity than the primary effluent because the secondary discharge will contain almost twice as much ammonia as the primary discharge. As previously described, the long-term effects of nutrient enrichment on the species composition and abundance of the phytoplankton community at the proposed outfall area cannot be quantified

at this time. However, since ammonia is known to increase plankton productivity during the summer period when other nitrogen sources have been exhausted, the potential for enhanced algal productivity exists.

Effects on Benthos

Sedimentation

Sedimentation rates for the secondary wastewater discharge were evaluated to be about 32 percent of those for the primary effluent (refer to Appendix A). Thus, no adverse impact to the local benthic community is anticipated as a result of burial from this material.

As previously discussed, for the primary effluent, the potential for bioaccumulation of pollutants as a result of sedimentation is considered to be small, due to the dispersive nature of the environment at the recommended outfall site. The substantial reduction of settleable materials in the secondary effluent will further reduce the potential for bioaccumulation.

Fisheries

Secondary treatment discharge impacts are not expected to be significantly different from primary impacts. The principal indirect impact may be due to the greater discharge of ammonia and the resulting change in phytoplankton abundance and/or community structure. The actual impact of this change cannot be accurately predicted, however, it is not expected to result in adverse effects on fishery resources or fishing activities.

8.3.3 MARINE ARCHAEOLOGY

A summary of the Phase I documentary research, which evaluated the potential for impacts to historic shipwrecks from outfall construction, is provided in Appendix HH. This evaluation concluded that the recommended outfall area, Sites 4.5 and 5.0, has the lowest potential of all the candidate sites for affecting marine archaeological resources. This conclusion is based upon the fact that the recommended outfall area is the furthest removed from locations which have the highest frequency of documented shipwrecks: areas closer to mainland shores and the Harbor islands, and the area in the vicinity of the outer Harbor channel. Furthermore, the documentary research has indicated that all documented wrecksites in the proximity of the outfall study areas occurred after 1919. This diminishes their potential historic value, in light of federal and state criteria for eligibility as historic resources.

In accordance with state and federal law, scientific excavation of an historic shipwreck would be required if a marine archaeological resource were to be affected as a result of outfall construction. Since archaeological excavation could seriously affect the construction schedule for the outfall, avoidance of any potential marine archaeological resource would be recommended in selecting the location of the final outfall within the recommended area.

A low potential for affecting undocumented, but known wrecksites exists for the recommended outfall area. These wrecksites are marked on navigational charts as potential hazards to navigation, and are unlikely to be historic resources. While it is likely that any

undocumented but charted wrecksite is less than 100 years old, in consideration of federal and state preservation requirements, the acquisition of field evidence is recommended which would document that marine archaeological resources would not be affected from outfall construction.

It is recommended that additional geotechnical field programs be undertaken to provide a more definitive characterization of the recommended outfall area, and to assist in ultimately selecting the outfall location within the recommended area. The field information obtained from these programs could be evaluated to determine whether a shipwreck exists within the selected outfall site.

In accordance with Section 106 review procedures, it is anticipated that a Memorandum of Agreement between EPA, the Massachusetts Historical Commission, and MWRA will be executed for this project, which would address the need to avoid an historic shipwreck site in selecting the final outfall location within the recommended area. Evaluation of remote, field geotechnical data should be performed to ensure the avoidance of a marine archaeological resource. Based on the lack of any known marine archaeological resources within the outfall area, and the presumed commitment to avoid a marine archaeological resource in siting and constructing the outfall, it is concluded that outfall construction will have no impact on marine archaeological resources.

8.3.4 TRANSPORTATION

Construction activities associated with the outfall and tunnel will be focused at two locations: the access shaft on Deer Island, through which all materials, equipment and workers required for tunnel construction will be transported, and the outfall location, which is approximatley 7.9 to 9.3 miles east-northeast of Deer Island. Transportation requirements to Deer Island for construction of the effluent tunnel include initial transport of construction equipment, periodic delivery of sand and gravel for concrete mixing, removal of excavated tunnel spoils from Deer Island, and the daily transport of workers to and from the site during all phases of construction. Workers, construction equipment, and materials required for the outfall will be transported directly to the outfall location from on-shore pier facilities.

The volume of spoil material from the riser excavation is approximately 12,000 yd^3. This material will be disposed of in the Corps of Engineers Designated Foul Area. Approximately 1.44 to 1.86 million yd^3 of spoil material will be removed from the tunnel. This material may be used to make concrete aggregate or may possibly be used by other local projects (i.e. Third Harbor Tunnel). Studies are being conducted to determine the most suitable end point for this material.

The first activities associated with the construction of the recommended alternative will be the construction of the outfall diffuser and the vertical access shaft. Diffuser construction will begin in early 1991. Construction of the vertical access shaft will, however, not begin until the pier facilities have been completed and the piers are in operation. This is also expected to be in 1991. Tunnel boring will begin after construction of the access shaft in late 1991; tunnel lining will be performed concurrently with boring operations, by using precast lining sections.

Construction of the risers will require between 35 and 40 workers per day and estimated truck trips will be about 5 per day. Construction of the outfall riser shafts will require between 100 and 120 workers per day and approximately 5 trucks per day.

Tunnel boring will require between 220 and 240 workers per day and approximately 105 to 115 truck trips per day. Finally, tunnel lining will require a workforce of 80 to 100 per day and approximately 105 to 115 truck trips per day. A more detailed description of the operations and materials associated with each of these activities is described in Appendix II of this Volume.

Tables 8.3.4-1 and 8.3.4-2 present the projected worker and truck volumes by year for each of the major activities.

It is expected that there will be essentially no transportation impacts to Winthrop which are associated with effluent outfall and tunnel construction activities. Only the contingency trucking of eight vehicles per day would travel through Winthrop. It is anticipated that half of the construction workers will be transported to the site via ferry from remote docking facilities, and the remainder will be transported by bus from satellite parking facilities. Materials will be transported to the site via on-shore pier facilities either by bulk or by roll-on-roll-off truck trips. Impacts associated with satellite parking facilities are described in Volume III of the STFP. Traffic impacts associated with the on-shore pier facilities are addressed in the On-Shore Water Transportation Facilities Plan.

8.3.5 NOISE

Construction activities for the effluent tunnel and diffuser system will be confined to Deer Island and the outfall location, approximately 8.5-9.5 miles east-northeast of Deer Island. These activities were evaluated to determine what noise could be expected at the closest residences on Point Shirley in Winthrop, and at Nahant. Source sound levels for the proposed equipment were drawn from CERL (1981) and ESEERCO (1977). The effects of hemispherical divergence (Beranek, 1971) and atmospheric absorption (CDM/S&W, 1986) were considered.

The analysis indicates that noise impacts associated with construction of the effluent tunnel and outfall will be at or lower than the evaluation criteria for daytime and nighttime noise, of 45 dBA and 39 dBA, respectively.

Deer Island Sound Levels

Activities at Deer Island will include construction of the vertical access shaft to the effluent tunnel, the tunnel boring operation, and the transport of spoils from the shaft and tunnel off-island via the pier facility. Construction of the tunnel will not be audible anywhere in Winthrop, since the boring equipment will always operate within the tunnel. Noise due to the removal and transport of effluent tunnel spoils to barges at the pier facility will be 49 dBA at Point Shirley.

TABLE 8.3.4-1
EFFLUENT OUTFALL CONSTRUCTION WORKER REQUIREMENTS PER DAY

Year	Existing Treatment Operations	Access Shaft	Tunnel Boring	Tunnel Lining	Diffuser Shafts*	Total
1991	60-70	35-40	220-240	80-100	100-120	95-570
1992	60-70	-	220-240	80-100	100-120	460-530
1993	60-70	-	220-240	80-100	100-120	460-530
1994	60-70	-	220-240	80-100	-	360-410
1995	60-70	-	-	80-100	-	140-170

*Workers and trucks will be transported to the site from a contractor's docking facility. These volumes will not be associated with Deer Island traffic.

TABLE 8.3.4-2
OUTFALL CONSTRUCTION
EXPECTED TRUCK VOLUME PER DAY

Year	Existing Treatment Operations	Access Shaft	Tunnel Boring	Tunnel Lining	Diffuser Shafts*	Total
1991	10-15	5	105-115	50-55	5	175-195
1992	10-15	-	105-115	50-55	5	170-190
1993	10-15	-	105-115	50-55	5	170-190
1994	10-15	-	105-115	50-55	-	165-185
1995	10-15	-	-	50-55	-	60- 70

*Workers and trucks will be transported to the site from a contractor's docking facility. These volumes will not be associated with Deer Island traffic.

The offshore construction activities for drilling the diffuser shaft system will be conducted in Massachusetts Bay approximately 8.75 miles from Point Shirley. This effort will be accomplished by two drilling rigs operating day and night from March through October during the years 1991 through 1993.

The mainland sound levels for the offshore drilling rigs was estimated in two ways. The first way assumes the usual hemispherical radiation (6 decibels per doubling of distance). The second method accounts for thermal inversions where the sound is "ducted," that is, it alternately reflects off the water and is refracted down again due to atmospheric conditions. This latter approach was calculated using 3 dB per doubling of distance beyond 1,000 ft. The estimated sound levels for Winthrop were determined to be 20 dBA or less for normal conditions and 35 dBA during conditions of atmospheric thermal inversions.

Nahant Sound Levels

Construction activities for the effluent tunnel and the removal and transportation of tunnel spoils off Deer Island via the pier facility will not be audible anywhere in the Nahant community. The offshore construction activities for drilling the diffuser shaft system is located approximately 5.6 miles from the southern tip of Nahant. Noise levels during this drilling operation will be 27 dBA or less during most atmospheric conditions. During certain inversion weather conditions, the sound levels may reach 41 dBA.

References

Camp Dresser & McKee (CDM)/Stone & Webster Engineering Corporation (S&W), 1986. "Report on Evaluation and Screening of Unit Process." Prepared for Massachusetts Water Resources Authority.

Construction Engineering Research Laboratory (CERL), 1981. "Noise Control: Pile Driver Demonstration Project, Waterloo, Iowa." Technical Report N-111, p. 41.

Empire State Electric Energy Research Corporation (ESEERCO), 1977. "Power Plant Construction Noise Guide." Prepared by Bolt Beranek and Newman Inc.

8.4 PUBLIC HEALTH ASSESSMENT

8.4.1 INTRODUCTION

This section presents the results of the public health assessment performed for the recommended outfall location and treatment schemes. The assessment reported herein describes the incremental, upper-bound risks associated with the consumption of contaminated seafood obtained from an area affected by the outfall. In addition, an incremental impact assessment was made of the potential effects of swimming at local beaches receiving additional pathogens from the recommended outfall. Details of the entire public health assessment are provided in Appendix C.

The purpose of this analysis is twofold. First, the potential incremental risks are calculated to determine if the outfall, regardless of location, presents a significant, unacceptable risk to the public. Second, the risk assessment process was performed in reverse to determine concentrations of contaminants that result in an acceptable risk. This was performed by first setting an acceptable cumulative risk level (10^{-6} or 1 in a million) and then back calculating through the risk equations to obtain the "acceptable" water column concentration of contaminants from the recommended outfall site. The quantification of potential risk was based on existing EPA-approved toxicological indexes and risk assessment methodologies. No toxicological data or non-conventional risk assessment methodologies were utilized in this report. The second analysis is not discussed here since this section only describes the impact of the recommended plan. Details of the analysis can be found in Appendix C.

8.4.2 RISK ASSESSMENT PROCESS

The general format for risk assessment and all definitions of terms and equations used in this report are consistent with those established by the National Research Council (1983) and the EPA (1984i, 1984b, 1984c, 1985c). As provided by these authorities, the complete risk assessment includes the following major steps:

- Hazard identification: Identification of substances of concern, and qualitative evaluation of the potential for a substances to cause adverse health effects (e.g., birth defects, cancer) in animals or in humans.

- Dose-response assessment: Quantitative estimation of the relationship between the dose of a substance, and the probability of an adverse health effect.

- Exposure assessment: Characterization of the populations exposed to the toxic chemicals of concern; the environmental transport and fate pathways; and the magnitude, frequency, and duration of exposure.

- Risk characterization: Estimation of risk for the health effect of concern, based on information from the dose-response, and exposure assessments.

This risk assessment approach provides a framework for consistent, systematic estimation of health risk, with clear statements of assumptions and uncertainties. A summary of the relevant equations and definitions of terms required by this risk assessment is provided in Appendix C.

Model uncertainty is important when considering absolute risk estimates (e.g., Cothern et al., 1986). These uncertainties have been estimated and incorporated into EPA potency factors and reference doses as used in this report. It is important to note that although the incremental risks reported in this study are presented as absolute risks, they should be considered "most-plausible upper bound" risks because upper bound estimates are used by EPA to develop the carcinogenic potency factors and RfDs. All other uncertainties are substantially less than an order-of-magnitude, and are considered secondary uncertainties. A detailed discussion of uncertainties is described in Appendix C.

Hazard Identification

One of the hazards (or risks) assessed in this appendix is associated with human consumption of seafood containing pollutants that may originate from the MWRA outfall. The presumed chain of events is as follows:

1. Chemicals are discharged from MWRA outfall into Massachusetts Bay;

2. Chemicals are dispersed and diluted within the Bay waters by natural factors (tides, currents, degradation, volatilization, etc.);

3. Residual chemicals in Bay areas affected by outfall are taken up by marine species used for seafood (primarily finfish and lobster);

4. Seafood from affected areas is caught by commercial and recreational fishermen and a portion of the affected seafood is consumed by humans in the local population;

Consumption of seafood affected, as described here, presents certain toxicological risks both carcinogenic and non-carcinogenic.

An initial list of approximately seventy chemicals of potential concern was prepared from lists of chemicals found in the influent to the existing MWRA treatment plant, and from lists of chemicals found in the waters and sediments of Boston Harbor and Massachusetts Bay (see Appendix C). The lists include many industrial chemicals (including chlorinated solvents and PCBs), several metals and metalloids, pesticides, and PAHs.

From this initial list of about 70 chemicals, eleven were found to be the most likely to result in human health impacts.

These chemicals were selected for the detailed risk assessment and are listed in Table 8.4.2-1.

Exposure Assessment

The exposure assessment for the toxic chemicals included:

- Modeling the fate of pollutants discharged into Massachusetts Bay; water column and sediment concentrations were established for numerous zones in the Bay (a detailed description of the modeling is provided in Appendix A);

- Obtaining literature values or estimates for bioconcentration factors (BCFs) that are ratios of chemical concentrations found in marine biota to the chemical concentrations found in the surrounding water

- Using the BCF values, model-generated water (and sediment) concentration values and estimates of the fractional time various species spend in areas affected by the outfall, to estimate chemical concentrations in the edible portions of commercially important seafoods. Estimates were adjusted based upon the fat content of the species;

TABLE 8.4.2-1

INDICATOR COMPOUNDS FOR HEALTH ASSESSMENT

Compounds	Carcinogen	Toxic Hazard
Aldrin	X	X
Dieldrin	X	X
Chlordane	X	X
PCBs	X	
Hexachlorobenzene	X	
DDT	X	X
PAH	X	
Cadmium		X
Chromium VI		X
Lead		X
Mercury		X

- Conducting a survey of the local seafood catch and consumption patterns, with a focus on catches in areas of the Bay affected by the outfall;

- Estimating, for a "local" population defined as the Boston Standard Metropolitan Statistical Area (SMSA), the average intake of each contaminant due to the consumption of seafood from areas affected by the outfall.

Table 8.4.2-2 lists the most important fish and shellfish caught in areas of Massachusetts Bay that will be affected by the outfall. The landings of Atlantic herring and lobster dominate in terms of quantity landed (96 percent of the catch of edible seafood in 1986). It should be noted that there are differences between landing discussed here and fisheries catch statistics discussed in Sections 8.2 and 8.3. The herring and mackerel have the highest fat (lipid) content and thus would tend to bioconcentrate toxic organic chemicals (per unit body weight) to a larger extent than other species under equal exposure conditions. A mitigating factor for these two species, however, is that they spend only a fraction of the year in the areas affected by the outfall.

While the United States as a whole is estimated to utilize more than 20 billion pounds (round weight basis) of seafood per year, the actual amount of seafood consumed by the subpopulation of interest (the Boston SMSA) is about 150 million pounds (edible weight) per year. For this subpopulation, it is estimated that 2.8 percent of the finfish, and 9.1 percent of the lobster come from areas of Massachusetts Bay that will be affected by the recommended outfall.

Fish tissue concentrations were estimated for the 11 identified chemicals in 12 seafood species. Where appropriate, pelagic and demersal species were considered differently in order to properly represent uptake from water versus uptake from sediments.

8.4.3 HEALTH RISK EVALUATION

Once exposures were quantified, a risk associated with the exposures was calculated. For carcinogens, risk values were generated using potency factors developed by the U.S. EPA's Carcinogen Assessment Group (CAG). These factors are based on extrapolations from high doses in animals to low doses in humans using a linear extrapolation model. This extrapolation is uncertain and provides a rough but plausible estimate of the upper limit of risk.

For non-carcinogens, a hazard ratio was calculated that compared the estimated exposure to a reference dose value. If the value of the ratio of predicted intake to acceptable exposure (the hazard ratio) is less than one, no adverse effects are expected. Table 8.4.3-1 presents hazard ratios for the non-carcinogens evaluated.

Table 8.4.3-2 shows that the majority of the total risk is caused by PCBs. In fact, PCBs alone contribute 3.90×10^{-7} risk. These are quite significant impacts. Nevertheless, it is important to remember that the risks are calculated for persons ingesting 20 grams and 165 grams of seafood per day for 50 years. These are extremely conservative scenarios, and even though the contaminants selected for this analysis are very persistent in the environment, within 50 years, PCBs will slowly degrade.

TABLE 8.4.2-2

FISH AND SHELLFISH SPECIES
LANDED IN BOSTON, MASSACHUSETTS

Species	Catch Makeup
Atlantic herring (Clupea herengus)	(61%)
American lobster (Homerus americanus)	(35%)
Winter flounder (Pseudopleuronectes americanus)	(1.5%)
Cod (Gadus morhua)	(0.5%)
Yellowtail flounder (Limanda ferruginea)	(0.1%)
Red, white hake (Urophycis tenuis, chuss)	(1.0%)
Mackerel (Scomber scombrus)	(<0.1%)
American plaice (Hippoglossoides platesoides)	(<0.1%)
Silver hake (Merluccius bilinearis)	(N/A)
Bluefish (Pomatomus saltatrix)	(N/A)
Scup (Stenotomus versicolor)	(N/A)
Ocean pout (Macrozoarces americanus)	(N/A)
Soft shell clam (Mya arenaria)	(N/A)

TABLE 8.4.3-1

HAZARD RATIO FOR RECOMMENDED SITE

	Hazard Ratio	
	Average	Maximum
Non-Carcinogens		
*Aldrin/Dieldrin	1.41×10^{-4}	1.17×10^{-3}
*4,4-DDT	1.87×10^{-5}	1.54×10^{-4}
*Chlordane[a]	NA	NA
Chromium (VI)	2.39×10^{-6}	1.97×10^{-5}
Cadmium	1.96×10^{-5}	1.62×10^{-4}
Mercury	8.85×10^{-5}	7.30×10^{-4}
Lead	1.10×10^{-4}	9.04×10^{-4}
Total	4.82×10^{-4}	3/14x10^{-3}

*These substances have both carcinogenic and non-carcinogenic effects.
[a] Data for chlordane will be added in the final report.

TABLE 8.4.3-2

RISKS FOR SITE 5 FOR AVERAGE AND MAXIMUM CONSUMPTION RATES

Pollutant	Carcinogenic Risk Average	Maximum
Carcinogens		
*Aldrin/Dieldrin	4.83×10^{-8}	3.99×10^{-7}
PCBs	3.90×10^{-7}	3.2×10^{-6}
Hexachlorobenzene[a]	NA	NA
*4,4-DDT	3.17×10^{-9}	2.62×10^{-8}
PAH (B(a)P)	7.13×10^{-9}	5.88×10^{-8}
*Chlordane[a]	NA	NA
Total	4.5×10^{-7}	3.7×10^{-6}

*These substances have both carcinogenic and non-carcinogenic effects.

[a] Data for chlordane and hexachlorobenzene will be added in the final report.

Performing a risk assessment for effluent from a wastewater treatment plant presents certain problems due to the number of different pollutants emitted. Primarily, the question arises as to the total toxicity of each individual pollutant. Ideally, an evaluation of the interaction of the different pollutants should be conducted to determine the total toxicity of the mixture and possible synergistic effects (that is, the total effect being greater than the sum of the effects taken independently). In the absence of this information, EPA has published guidelines that instruct preparers of risk assessments to assume additivity of risks. Using this approach, the total risk of contracting cancer for the recommended site for all pollutants resulted in a total of 3.7×10^{-6} (3.7 in one million) for the maximally exposed individual and 4.5×10^{-7} (4.5 in ten million) for the average exposure scenario. When the hazard ratios for non-carcinogens are added together, a total hazard ratio of 3.4×10^{-3} (0.0034) is obtained for the maximum scenario, and 4.82×10^{-4} (0.000482) for the average scenario. A safety factor can be calculated by dividing the hazard ratio into one. Taking this approach, an approximate safety factor of 300 for non-carcinogenic effects is obtained for the maximum group and 2000 for the average group.

Several approaches can be taken to determine whether or not the incremental risks predicted to result from operation of the proposed facility are acceptable. First, there is the issue of secondary treatment compared to primary wastewater treatment, as is currently practiced. While secondary treatment will contribute to the total risk to each individual, primary treatment, as currently practiced, also has an incremental, though unquantified risk associated with it. Therefore, the current situation is not a zero-risk option. Thus, when considering the acceptability of the proposed wastewater treatment plant, it must be recognized that its alternatives are not without their own risks.

A second approach is to compare the estimated risks to the risk incurred in daily life. Table 8.4.3-3 presents risks associated with common, voluntary activities. As can be seen, risks much greater than the 4.57 in ten million are engendered by a variety of everyday activities. This plainly puts the risk associated with the proposed facility into a clearer perspective.

Another approach to determining the significance of a risk is to define a level of risk that is considered acceptable. For example, EPA, in establishing Water Quality Criteria, stated that risks of 10^{-5} (one in 100,000) to 10^{-7} (one in 10,000,000) could be acceptable. The United Stated Food and Drug Administration has adopted 10^{-6} (one in 1,000,000) level for risks associated with a contaminant in food. The risks posed by the facility can be directly compared to these criteria because the source of the risk is consumption of organisms affected by contamination of water. However, the conservatively estimated risks from the facility obtained in this assessment are consistent with the range of acceptability established for other public policy decisions such as those described above.

In conclusion, based on the thorough and conservative analysis presented, the risks associated with chemical pollutants estimated to be emitted from the proposed facility, both carcinogens and non-carcinogens, are acceptable.

TABLE 8.4.3-3

COMPARISONS OF EVERYDAY RISKS

Risk of Death	Risk/Year	Risk/Lifetime*
Motor Vehicle (in 1975)	2.2×10^{-4}	1.5×10^{-2} (1.5 in 100)
Skiing - 40 hr/yr engaged in sport	3×10^{-5}	2.1×10^{-3} (2.1 in 1,000)
Canoeing - 40 hr/yr engaged in sport	4×10^{-4}	2.8×10^{-2} (2.8 in 100)
Rock climbing (U.S.) - 40 hr/yr engaged in sport	1×10^{-3}	6.8×10^{-2} (6.8 in 100)
Fishing (drowning) - averaged over fishing licenses	1×10^{-5}	7×10^{-4} (7 in 10,000)
Drowning (all recreational causes, U.S.)	1.9×10^{-5}	1.3×10^{-3} (1.3 in 1,000)
Bicycling	1×10^{-5}	7×10^{-4} (7 in 10,000)
Extrapolated Cancer Risks		
One transcontinental flight/year (cosmic ray risk)	5×10^{-7}	3.5×10^{-5} (3.5 in 100,000)
Average U.S. diagnostic medical x-ray (radiation risk)	1×10^{-5}	7×10^{-4} (7 in 10,000)
One diet soda/day (saccharin)	1×10^{-5}	7×10^{-4} (7 in 10,000)
Four tablespoons peanut butter/ day (aflatoxin)	4×10^{-5}	2.8×10^{-3} (1.8 in 1,000)
Smoker, cancer only	1.2×10^{-3}	8.1×10^{-2} (8.1 in 100)
Smoker, all effects (including heart disease)	3×10^{-3}	1.7×10^{-1} (1.7 in 10)
Person in room with smoker	1×10^{-5}	7×10^{-4} (7 in 10,000)

*Risk/lifetime = $1\text{-}1(\text{-}p)^{70}$ (p=risk/year).
SOURCE: Ricci, 1985.

8.4.4 PATHOGEN ASSESSMENT

This section presents an analysis of the potential public health impacts associated with exposure to pathogenic bacteria and viruses from a discharge at the recommended site. The assessment covers only the incremental impact associated with the recommended MWRA outfall site.

The scope of the assessment involved estimating the potential for incidence of illness associated with swimming at major beaches in Revere, Nahant, and Hull, based upon predicted levels of both indicator bacteria and viruses that originate from the outfall. This section follows a similar tact to that of the non-conventional pollutant assessment.

Pathogen Identification

Diseases whose pathogenic agents are found in the feces of individuals or carriers can potentially be contracted by either swimming in contaminated waters or by consuming shellfish harvested from contaminated waters. The use of fecal indicator organisms (such as the coliform group) for indexing health hazards in drinking and recreational waters have been used since the early 1900s.

Fecal coliforms remain the indicator organisms recommended by EPA for assessing the quality of both drinking and recreational waters, since it is recognized that (a) there are large numbers of pathogenic bacteria and viruses potentially present in municipal sewage; (b) monitoring for each pathogen on a routine basis would be an impossible task; (c) reliable methods of analysis for some of the more important pathogens are unavailable, while others are difficult to quantify; and (d) the intent is not to index the presence of pathogens but rather their potential to be present at levels which cause unacceptable health effects (U.S. EPA, Health Effects Criteria, 1983).

Viruses have been included as indicator organisms for the assessment because of their resistance to disinfection techniques such as chlorination. Therefore, evaluating the quality of chlorinated secondary effluent based on fecal coliform levels is not necessarily an accurate reflection of the virus levels that may remain following the chlorination process. Hence, for the purposes of evaluating potential health impacts from exposure to pathogens discharged from the candidate outfall locations identified in this report, both fecal coliforms and viruses are used as indicator organisms.

Hazard Identification

Health hazards are associated with individuals swimming in marine waters containing pathogenic bacteria and viruses (e.g., exposure via ingestion) that may originate from the MWRA outfall. The major hazard associated with the discharge is contracting an infectious disease as a result of swimming in waters contaminated with human, and to a much lesser extent, lower-animal fecal wastes. These diseases include: bacterial diseases such as salmonellosis (including typhoid fevers), shigellosis, cholera and gastroenteritis; viral diseases such as infectious hepatitis, illnesses caused by enteroviruses (poliovirus, coxsackievirus A and B, reovirus, adenovirus),

and non-specific gastroenteritis caused by human rotavirus and parvo-like virus, and diseases caused by a variety of parasites (e.g., amoebic dysentary, giardiasis) (U.S. EPA, 1983).

Water quality guidelines and standards for primary contact recreational waters have been promulgated by federal, state, and local agencies for protection against contracting these diseases. These guidelines are set as upper limits for fecal coliform counts. The current EPA standard states that "the fecal coliform bacterial level should not exceed a log mean of 200 fecal coliform (Most Probable Number)/100 ml based on a minimum of 5 samples over a 30-day period nor shall more than 10% of the total samples taken during a 30-day period exceed 400 fecal coliform/100 ml.

It should be noted that, based on recent studies, EPA is strongly recommending that enterococci replace fecal coliforms as the indicator organism for marine waters (U.S. EPA, 1986).

The water quality guideline or standard for protection of shellfish harvesting waters has been set by EPA at 14 fecal coliform/100 ml for fecal coliform levels.

To date, there are no federal guidelines or standards regulating virus levels in fresh or marine waters. It is worth noting that the majority of illnesses associated with swimming are gastrointestinal illnesses, with viruses being the suspected agent (Cabelli, 1983). Hence, this exposure pathway is of primary concern.

Exposure Assessment

Potential exposure pathways have been identified and evaluated in this section of the pathogen assessment. An exposure pathway is considered complete if the following exist: source of contamination; a migration pathway; a potential receptor; and a route of exposure. All of these components are evaluated in this section.

Estimates of Microbial Contaminant Concentrations in Treated Effluent

Bacterial. Based on the requirements of the draft NPDES permit regulating the discharge from the proposed secondary treatment facilities, the treated effluent will not contain fecal coliform levels greater than 400 fecal coliform/100 ml on a daily basis and will not exceed an average of 200 fecal coliform/100 ml on a monthly basis.

Viral. It is important for the purpose of properly evaluating health risks to potential receptors to also estimate virus levels in the treated effluent. Because virus standards do not exist for discharges to fresh or marine waters, nor are there any available data on current virus levels for Deer Island effluent as it is now treated, virus levels for the proposed treatment processes were estimated from the scientific literature. Based on estimates from several sources, it was determined that a concentration of 1000 Plaque Forming Units (PFU)/liter, e.g., 1000 viruses per liter of wastewater, is typical for metropolitan wastewater in the United States. Assuming a removal efficiency of 6.6 percent for primary treatment, 94 percent for secondary treatment (activated sludge), and a subsequent 90 percent viral removal following a chlorination process, it is estimated that the treated secondary effluent will contain 6 PFU/liter (Leong, 1983).

Modeling of Fate and Transport of Microbial Contaminants

Bacteria. A dispersion model was used to determine the fate and transport of predicted effluent fecal coliform levels, as defined by the draft NPDES permit requirements (e.g., 400 /100 ml daily maximum), at the recommended outfall location. Fecal coliform levels at the edge of the mixing zone will be less than 14/100 ml (e.g., the Water Quality Standard for shellfish-harvesting waters) 100 percent of the time.

Viruses. The same models are also used to predict the fate and transport of the virus levels estimated to be present in the discharge. An additional assumption used for modeling purposes was that viruses have a much longer survival time (up to 60 days) in sea water than fecal coliform bacteria (Metcalf and Stiles, 1966) and hence, can be dispersed further while still viable. Table 8.4.4-1 shows the virus levels from the recommended outfall at each of the sensitive shoreline areas.

Risk Assessment

The potential adverse health effects associate with exposure to pathogenic bacteria or viruses as a result of discharges from the proposed outfall locations are assessed in this section. As stated previously, the evaluation includes only the incremental impact associated with the candidate MWRA outfall locations.

Impact to Swimmers

The result of the dispersion model revealed that at the edge of the mixing zone, fecal coliform levels will be reduced to less than 14 /100 ml, which is well below the standard of 200 /100 ml set by EPA for recreational marine waters. In addition, given that the half-life of fecal coliform in sea water ranges from 6-10 hours, the transport of pathogenic bacteria to local beaches is highly unlikely.

Viruses, on the other hand, which have greater resistance to chlorination as well as a greater rate of survival in sea water, can potentially be transported to local beaches.

In terms of correlating the predicted virus levels with the risk of incidence of illness (specifically gastrointestinal) at this time, there is no accepted methodology for establishing such a correlation. However, based on the use of several assumptions obtained from the scientific literature, the predicted virus levels at sensitive shorelines have been converted to incremental risk values. These results are presented in Table 8.4.4-1. As a basis for comparison, the results of an epidemiological study conducted in 1975 by EPA at two Boston Harbor beaches are also presented in Table 8.4.4-1. The EPA study revealed that the Revere and Nahant beaches had an incidence or rate of gastrointestinal illness of 19/1000 swimmers and 6/1000 swimmers, respectively. However, the values estimated for swimming at beaches by the discharge the recommended MWRA outfall location are significantly lower (e.g. ranging from 1/5250 to 1/83,300, which are 1 to 2 orders-of-magnitude lower) compared to the actual illness rates determined by the EPA study. It should also be noted, as a basis for comparison, that the acceptable incidence or incremental risk of illness associated with EPA's current

TABLE 8.4.4-1

PREDICTED VIRAL LEVELS AT NEAREST SENSITIVE SHORELINE AREA FROM RECOMMENDED SITE

	Levels at Sensitive Shorelines		
Parameter	Revere	Nahant	Nantasket
Primary Effluent			
Estimated Virus Levels (Viruses per liter)	0.22	0.22	0.19
Estimated Risk of Illness (Incidence of Illness per 1000 Swimmers)	0.22	0.22	0.19
Secondary Effluent			
Estimated Virus Levels (Viruses per liter)	.014	.014	.012
Estimated Risk of Illness (Incidence of Illness per 1000 Swimmers)	.014	.014	.012
Actual Illness Rates from 1975 EPA Study (Incidence of Illness per 1000 Swimmers)	19	6	N.A.

recreational water standard for fecal coliform levels (200 coliform/100 ml), as well as EPA's newly recommended criterion for enterococci levels (35 /100 ml in marine waters only) is 19 illnesses/1000 swimmers at marine beaches (U.S. EPA, 1986). Therefore, the potential health impacts for swimmers associated with discharges from the recommended outfall location would be negligible.

Impact to Shellfish Consumers

The Boston Harbor shellfish beds are currently directly affected by current sewage treatment practices. At the present time, all the shellfish beds in Broad Sound (Revere, Nahant) and Boston Harbor (Winthrop, Boston, Dorchester, Quincy, Hingham) are either permanently closed or restricted to all except Master Diggers. The restricted beds are automatically closed for 3-5 days whenever flows at the Nut or Deer Island facility exceed available treatment capacity resulting in a bypass of primary treatment. Bypassing primary treatment results in direct discharge of raw sewage, with a corresponding rise in fecal coliform levels throughout the Harbor.

It is readily apparent that the location of the proposed outfall will have a dramatically beneficial impact on the shellfish beds in Dorchester, Quincy, and Hingham Bays. In addition, occasional closings of Nantasket Beach due to contamination from the Deer Island facility discharges will be eliminated. It should be noted that CSOs discharging to Boston Harbor are still likely to affect these resources, but the MWRA CSO program should alleviate the majority of these problems in the future.

8.4.5 SUMMARY OF PUBLIC HEALTH ASSESSMENT

Health Risk Assessment

This analysis calculated lifetime risks of excess cancers that could be expected as a result of exposure to contaminants through ingestion of fish and shellfish from the study area in Massachusetts Bay. Risks were calculated for the recommended area using two different rates of consumption: 20 grams (0.64 ounces) per day and 165 grams (5.3 ounces) per day. Table 8.4.3-2 shows the total estimted risks (for carcinognes) and table 8.4.3-1 shows the hazard ratios (for non-carcinogens) for each site at the 20 grams per day (average) and 165 grams per day (maximum) consumption rates.

Using the average consumption rate (20 g/day), the risk is in the 4.5×10^{-7} range (or 4.5 in 10,000,,000 excess cancers expected) over a 50-year (projected lifetime) exposure. Using the maximum consumption rate (165 g/day) the risk is 3.7×10^{-6} (3.7 in 1.000.000). Most of the risk comes from concentrations of PCBs.

All of the non-carcinogenic hazard ratios are below a value of 1. Therefore, they should not be considered a concern. The subpopulation most affected by the levels of contaminants in the water and sediments is the group of people who eat large quantities of fish, such as local recreational fishermen who keep large portions of their catch for personal consumption.

Pathogen Assessment

With regard to human exposure and risk associated with pathogens (bacteria and viruses) in the MWRA effluent, the following conclusions are reached:

- Incremental risks associated with potential exposure to bacteria (e.g., those for which fecal coliform are good indicators) are expected to be negligible. It is expected that the secondary effluent will result in a fecal coliform count of less than 14 /100 ml, which meets the Water Quality Standard for shellfish-harvesting waters, at the edge of the zone of initial dilution (approximately 100 feet from the outfall). This estimated fecal coliform count is well below the 200 /100 ml standard typically set for swimming beaches.

- Incremental risks associated with swimmers' exposure to viruses on beaches are also expected to be negligible. Incremental virus levels at the beaches in Boston Harbor and Massachusetts Bay are in the range of 0.1 to 2 viruses per 10 liters of water. These levels are expected to result in an incremental risk of illness to swimmers in the range of 1/5,000 to 1/80,000. These illness rates are 1 to 2 orders-of-magnitude below levels considered to be acceptable.

8.5 MITIGATION MEASURES

A significant mitigation package was developed as an integral part of MWRA's decision to site the new secondary treatment facilities on Deer Island. Because MWRA is committed to alleviating the impacts associated with the construction and operation of the treatment facilities, the previous mitigation commitments are also an integral part of the facilities planning process.

The mitigation commitments are comprised of the following:

- Flow and Growth
- Operation and Maintenance
- Odor Control
- Noise Control
- Barging and Busing
- Trucking of Liquid Chlorine
- Relocation of Deer Island House of Correction
- Further Measures to be Examined

Summary descriptions of each of the mitigation commitments and a statement of the applicability of each commitment for use as an evaluation criterion were provided in the Technical Memorandum - Proposed Criteria For Detailed Evaluation of Alternatives, Secondary Treatment Facilities Plan, dated May 13, 1987. The above commitments were reviewed to categorize all necessary mitigation commitments which support the early site preparation plans. A summary of these commitments, specific to outfall siting and construction is provided below.

Outfall Siting and Outfall Design

A continuing dialogue has occurred between MWRA, regulatory agencies, and various citizens' groups to define relevant criteria which were used to select the recommended outfall area. The 28 different criteria were broadly categorized into Environmental and Engineering (which included, Technical, Cost, and Institutional Criteria). The environmental criteria addressed the following issues:

- o Ability to Meet EPA Ambient Water Quality Criteria;
- o Ability to Meet Massachusetts Water Quality Standards;
- o Avoidance of Adverse SedAccumulation;
- o Ability to Protect Local Species From Adverse Stress;
- o Avoidance of Areas of Important Habitat;
- o Ability to meet Water Quality Criteria to Prevent Taste and Odors;
- o Maintenance and Enhancement of Aesthetic Conditions;
- o Protection of Shoreline Areas;
- o Protection of Commerical On-the-Water Activities;
- o Protection of Marine Archaeological Resources;
- o Construction Traffic and Noise.

In a very real sense, the selection of the recommended outfall site represents a mitigating measure, since the recommended location represents the most acceptable solution with respect to all environmental issues shown above. Furthermore, the recommended outfall design, consisting of an effluent tunnel bored through rock, and drilled outfall riser shafts, significantly mitigates construction impacts to the marine community (which would otherwise be expected as a result of alternative construction techniques such as dredging).

Barging and Busing

Traffic impacts to Winthrop have been mitigated by providing over-water transportation for all construction materials and equipment, and approximately one-half of the construction workers. Busing and satellite parking facilities will be utilized by the remaining construction workers.

8.6 IMPLEMENTATION

In order to implement the recommended plan in a timely fashion, several actions must be undertaken. The detailed schedules described in Volume VII of the STFP indicate that the recommended plan can be brought on-line in 1995, at the same time as the operation of the new primary plant. If a portion of the new primary plant is placed in operation in advance of 1995, the existing plant outfalls will have to be used for this interim period.

It should be noted that the recommended plan is not expected to be completed by the federal court target date of July, 1994. MWRA may, during the design and construction phases, seek alternative proposals designed to expedite the construction.

There are several initiatives which MWRA must undertake in a timely manner. The recommended plan for implementation includes:

- Prepare a Request for Proposals (RFP) for geotechnical data collection. It is critically important that bathymetery and geotechnical information from the recommended region be collected starting early in the summer of 1988. The development of the scope of this service and associated documents should begin immediately so that the contractor can be on board in sufficient time to collect field data during the summer months.

- Coordinate outfall design issues through the Program/Construction Manager and Lead Engineer Teams. The teams selected for these assignments must show demonstrated capabilities in the tunnel and marine diffuser areas.

- Focus source control strategies. The investigations to date indicate that several pollutants should be given priority for source control through either industrial pretreatment or nonindustrial source control strategies. A coordinated effort should be undertaken with the Sewerage Division's Water Quality group to plan strategies for the control of these constituents.

- Develop internal capabilities regarding marine water quality issues. There is an ever-increasing interest in marine water quality management evolving in the Commonwealth. Complex scientific and regulatory issues will continue to be discussed, and the conclusions reached will have a substantial impact on MWRA. MWRA must develop an enhanced internal capability to participate in these discussions. It is also recommended that MWRA consider developing an internal capability to conduct its own monitoring programs so that the clean-up of the Harbor can be fully documented and a clear basis will exist for future environmental programs.

- Continue a limited field program between now and early 1988. It is recommended that a limited program be undertaken over the next few months to form a bridge between the facilities planning studies and the commencement of large-scale Massachusetts Bay Program. The information developed in this period can also be used to evaluate concerns over possible seasonal alterations.

Section 9

9.0 INSTITUTIONAL CONSIDERATIONS

9.1 EVALUATION CRITERIA

The purpose of this section is to evaluate candidate sites for the effluent outfall according to the institutional criteria previously approved. The institutional criteria defined in Section 7, Evaluation of Outfall Alternatives, include:

- the difficulty in achieving timely implementation;
- the flexibility to facilitate phasing of the primary or secondary plant, thereby expediting the overall construction;
- the permitting effort required;
- the degree of internal coordination required;
- the degree of external coordination required;
- the level of demand for unique construction resources.

Timely Implementation/Flexibility to Meet Project Phasing

The difficulty in achieving timely implementation and/or facilitating phasing of the treatment plant vary according to site selection, although the schedule for construction of the outfall tunnel and diffuser at all sites exceeds the July, 1994 target date contained in the federal court order. Sites 2, 2.5, and 3 are rated "Modest" in difficulty in achieving the schedule because they deviate only slightly from the target date. The estimated completion schedule for these three sites is 47 months. Sites 3.5, 4, and 4.5 exceed the target date but precede the new primary plant start-up by several months and thus are rated "Moderate" in difficulty. The outfall can be completed in 51 months at these three locations. Construction at Site 5 will be completed concurrently with primary plant completion and thus is rated "Difficult." An outfall tunnel to Site 5 will require approximtely 56 months to complete.

The ability to commence operation of the tunnel by the anticipated date is dependent on two critical assumptions: no unexpected rock conditions will affect the schedule and the selected method of constructing the tunnel and diffuser system; and MWRA will initiate a geotechnical field investigation program in the spring of 1988.

A detailed geotechnical field program consisting of a series of deep rock borings along the tunnel alignment is required to establish the final design parameters and construction approach. The current estimated completion date is based on assumptions regarding rock

strength and uniformity. The assumptions are reasonable, considering the information currently available. However, there is no information regarding the rock characteristics at the tunnel depth along the proposed route. Unexpected rock conditions could affect the method of construction and the choice of equipment for drilling the tunnel and the risers. At best, the proposed use of a tunnel boring machine would be judged feasible; a semi-submersible rig could be used to expedite drilling of the the risers, and the overall construction schedule could be shortened by several months. At worst, the construction schedule could be significantly lengthened if it is necessary to employ drill and blast techniques for a portion, or all of, the tunnel, or if a stationary rig is used to drill the risers.

To meet the projected tunnel completion date, it is recommended that the geotechnical field program begin in the spring of 1988. It is necessary for MWRA to prepare documents needed to advertise, bid, and award a contract immediately. Should the geotechnical investigation begin after the spring of 1988, the construction of the effluent outfall tunnel will be delayed beyond the projected completion date.

Permitting

The permitting requirements for each candidate site are equally "Extensive" in the number and type of approvals required. It is possible that a higher level of scrutiny may be applied to obtaining the permits for the inner sites due to concern about shoreline impacts.

The draft and final EID/EIR submittal dates for the outfall facility are November, 1987 and March 1988, respectively. Major permits and approvals must be obtained on the federal level from the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (ACOE). Under the provisions of the National Environmental Policy Act (NEPA), a favorable Record of Decision (ROD) must be obtained from EPA. In conjunction with the EPA review, the ACOE will assess the impact of activities in navigable waters. A federal agency permit will also be required from the U.S. Coast Guard for "Private Aid to Navigation," because of placement of temporary floats or moorings in areas affecting navigation. These will be placed in the Bay as a result of construction. Depending on the selected disposal options, an additional federal or state permit for ocean dumping of dredged or excavated material may be required.

Project approval at the state level is coordinated by the Executive Office of Environmental Affairs (EOEA) under the provisions of the Massachusetts Environmental Policy Act (MEPA). Major review and permitting activities are conducted by the Department of Environmental Quality Engineering (DEQE) and its Division of Water Pollution Control (DWPC). DEQE permits will include a "Water Quality Certification" and a "Chapter 91 Waterways License." Other state responsibilities include: a review for consistency with the Coastal Zone Management (CZM) Plan under the purview of the EOEA-CZM Program, and a Section 106 Historic Preservation Review by the Massachusetts Historical Commission. Table 9.1-1 lists the major federal, state, and local permits that will be required.

TABLE 9.1-1

MWRA DEER ISLAND SECONDARY TREATMENT FACILITIES
PERMITTING REQUIREMENTS: EFFLUENT OUTFALL CONSTRUCTION

PERMIT/APPROVAL AGENCY	ACTIVITY REQUIRING PERMIT/APPROVAL
FEDERAL	
Activities in Navigable Waters (ACOE)	Sediment dredging and/or construction of structures beyond the mean high water line in navigable and territorial waters
Ocean Dumping of Dredged or Excavated Materials (1) (ACOE/EPA)	Activities involving the transportation of dredged material for dumping in ocean waters
Private Aid to Navigation (USCG)	Placement of temporary or permanent floats and moorings in areas potentially affecting navigation
STATE	
EOEA Certification (EOEA-MEPA UNIT)	State permitting and approval process for projects meeting specified threshold criteria
Water Quality Certification (DEQE/DWPC)	Federal or state permitting activities for actions involving discharges to water, such as wastewater discharge, dredging, and residuals from construction of structures in navigable waters
Chapter 91 Waterways License (DEQE-Waterways)	Construction of structures seaward of the high tide line
CZM Consistency Review (Mass. CZM)	Federal funding/permitting action for activities located within or affecting the coastal zone of Massachusetts

NOTES:

(1) Possible permit requirement depending on selected disposal option

TABLE 9.1-1

MWRA DEER ISLAND SECONDARY TREATMENT FACILITIES
PERMITTING REQUIREMENTS: EFFLUENT OUTFALL CONSTRUCTION
(Continued)

PERMIT/APPROVAL AGENCY	ACTIVITY REQUIRING PERMIT/APPROVAL
Section 106 Historic Preservation Review (Mass. Hist. Comm.)	Removal/modification of structures which are eligible for inclusion in the National Register of Historic Places
LOCAL	
Wetlands Order of Conditions (Boston, Quincy, Winthrop Conserv. Comm.)	Filling, dredging, removing, or altering land in or near water bodies (within 100 ft. of the 100-year floodplain)

ABBREVIATIONS:

ACOE - U.S. Army Corps of Engineers
CZM - Coastal Zone Management
DEQE - Department of Environmental Quality Engineering
DWPC - Division of Water Pollution Control
EIR - Environmental Impact Report
EIS - Environmental Impact Statement
EOEA - Executive Office of Environmental Affairs
EPA - U.S. Environmental Protection Agency
MEPA - Massachusetts Environmental Policy Act
MHC - Massachusetts Historic Commission

Coordination and Unique Resource Requirements

External coordination requirements and the demand for unique construction resources are normally considered separately. However, given the unique resource requirements of the outfall tunnel and the competition for resources generated by other tunnel projects, the two institutional considerations are examined jointly.

The external coordination requirements and the demand for unique construction resources are similar for all candidate sites. In each case, however, there must be "Extensive" coordination with the two other local construction projects that will require similar resources: the Inter-Island Wastewater Conveyance system, which is part of MWRA's Secondary Treatment Facilities Plan; and the Third Harbor Tunnel Project, which is being constructed by the Massachusetts Department of Public Works (DPW). To ensure the availability of labor, equipment and suppliers, it will be necessary to be cognizant of the requirements of all three projects.

The construction of the tunnel will also need to be coordinated internally with MWRA's existing plant operations, so that any conflicts with the existing outfall pipeline can be avoided. However, the internal coordination requirements for each alternative site are considered "Minimal."

Section 10

10.0 PUBLIC PARTICIPATION SUMMARY

10.1 INTRODUCTION

In facing the monumental tasks associated with the successful implementation of the Deer Island Secondary Treatment Facilities Plan (STFP), MWRA instituted a comprehensive public participation effort. The measures included in this summary were designed to meet federal and state regulatory requirements associated with the project, to satisfy grant conditions, and to provide the most meaningful avenues of public input into the critical decisions to be made by MWRA. Through this program, MWRA's dialogue with the public has been ongoing; important policy decisions have been made and will continue to be made within the context of public knowledge and participation.

10.2 COORDINATION WITH OTHER HARBOR CLEAN-UP PROJECTS

Because the total Harbor clean-up program consists of many simultaneous efforts, the public participation activities associated with the STFP have been closely coordinated with public participation efforts being undertaken for other projects. Public participation coordination has mirrored similar efforts on the technical side, particularly with regard to overlapping concerns. Coordination occurs on several levels:

- Engineering and Public Affairs project staff and technical and public participation consultants for both the Deer Island Secondary Treatment Facilities Plan and Residuals Management Facilities Plan (RMFP) have met at least monthly to discuss coordination efforts and to review schedules and agendas for upcoming meetings.

- The public participation programs are coordinated through MWRA's Public Participation Coordinator and augmented by other Public Affairs staff, including media, intergovernmental, and community relations personnel, particularly when project components have a direct bearing on a particular community.

- The Citizens' Advisory Committee (CAC) have served to review work associated with both the Secondary Treatment Facilities Plan and the Residuals Management Facilities Plan and have been kept informed of developments on other projects, such as water transportation, CSOs and the setting of local limits for industrial discharges.

10.3 CITIZENS' ADVISORY COMMITTEE (CAC)

In July, 1986 the MEPA Unit of EOEA served notice of the formation of a Citizens' Advisory Committee for the STFP in the Environmental Monitor. In addition, notices were mailed to several hundred individuals and organizations, and an announcement was placed in On the Waterfront, the MWRA newsletter, which was mailed to more than 1,500 individuals, groups and agencies.

Pursuant to discussions among agencies, it was decided that this CAC would serve to review both the STFP and the RMFP. Active members of MWRA's informal CAC from Phase I of the RMFP were solicited for nominations to the STFP CAC.

On October 10, 1986, EOEA Secretary James S. Hoyte appointed 28 representatives and 15 alternate members to the CAC. The CAC consists of representatives of environmental, business, community, government and other interests. In addition, agency representatives are serving in a non-voting capacity. Table 10.3-1 at the end of this section lists the members of this committee.

Technical support from Authority staff and consultants has been provided to assist in interpreting data and reports for the CAC. Administrative support from Authority Public Affairs staff and public participation subconsultants includes preparation of agendas, minutes and CAC reports, and scheduling of meetings and workshops. In addition, funds were allocated in MWRA's Capital Expenditure Budget to cover expenses the CAC may incur.

The CAC has met on a regular monthly basis and has chosen to form subcommittees to examine specific issues. In addition, a workshop on project scoping took place in February, 1986. The subcommittees have met on an as-needed basis, generally on the fourth Monday of each month, from 4:30 to 6:30 p.m. at a location agreeable to the majority of participants. Sub-group meetings have been scheduled for the early part of each month as needed. Materials are distributed to the CAC at the end of each meeting for discussion at the following month's meeting. At times, it has been necessary to distribute these materials through the mail, however sufficient time is allocated for the CAC members to review the information and prepare for the discussion. Agendas, minutes and other materials are also distributed prior to the CAC meetings.

10.4 TECHNICAL ADVISORY GROUP (TAG)

As an adjunct to the public participation program, a technical advisory group has been formed to provide a mechanism for input from involved agencies as well as technical advice and support to the CAC. Representatives of agencies involved in regulatory, permitting, funding, or other capacities were solicited by the MEPA Unit of EOEA for membership on the TAG, as were former members of the siting EIS TAG formed under EPA's auspices. A list of those representatives is attached in Table 10.4-2 at the end of this section.

In order to benefit from MWRA's presentations to the CAC, and to assist the citizen representatives in understanding technical issues, TAG representatives are invited to attend all CAC meetings and workshops. They are provided with documents in advance of the meetings and are asked to provide written review and comment, to be returned to MWRA in a timely fashion.

With this arrangement, MWRA can benefit from the advice of the TAG without devoting large portions of the CAC's agenda to technical discussions which the citizen representatives may not fully understand. The TAG is also free to meet on its own or at the request of the agencies, such as EPA.

10.5 PUBLIC MEETINGS

Public meetings fall into several categories:

A. Forums--In order to clarify MWRA's overall program for interested constituent groups and the public-at-large, a forum was held in Boston in January, 1987. At this forum a total picture of the Harbor clean-up effort was presented. Two additional forums are planned for January and May of 1988.

B. Public Information Meetings--Public information meetings have been held at project milestones, including: Outfall Screening and Technology, in March, 1987 at Lynn and Quincy; and Early Site Preparation, Alternative Site Layouts, and recommended Inter-Island alternatives in July, 1987 in Boston. A public meeting on the status of facilities planning, excluding the outfall work, will take place in September, 1987. A public meeting devoted to the status of the outfall study will take place in November, 1987 at two locations.

C. Meeting with Affected Communities--In addition to its attempts to educate the CAC and the public-at-large, the Public Participation Program addresses the concerns of communities that are affected by the results of the decisions made during the study. MWRA's Community Relations Liaison with the town of Winthrop has attended monthly meetings of the town's Representative Citizens Committee to keep them informed, not only of ongoing operational and fast-track upgrade issues at the existing primary plant, but also of the progress of the Secondary Treatment Facilities Plan.

   MWRA also holds regular public meetings with the Winthrop community to update them on the STFP and to hear public concerns regarding key decisions. Similarly, MWRA's Boston/Quincy Community Relations Coordinator has attended monthly Nut Island CAC meetings. The Community Relations Coordinator for the northern sector of the MWRA service area will provide similar coordination efforts to communities that may be potentially affected by outfall siting decisions.

   Local elected and appointed officials are kept informed of all developments of the STFP, relative to their concerns through the Public Participation and Community Relations Coordinators.

D. Other Meetings

Additional public hearings have taken place or been scheduled at three locations each on Site Preparation background (October, 1987) and Inter-Island Conduit (October, 1987), Treatment Plant and Institutional Considerations (November, 1987), and on Outfall (January, 1988). Special request meetings with the MWRA Advisory Board and other groups and organizations have also taken place.

E. Responsiveness Summaries

Responsiveness summaries of all public information meetings and public hearings are available within four weeks after the public meeting.

10.6 OTHER INFORMATIONAL ACTIVITIES

The STFP project team has been involved in development of informational materials, including newsletters, public service announcements, press releases, an educational display, brochures, responsiveness summaries, and fact sheets for use at public and CAC meetings, as well as for distribution through mailing lists, repositories, schools, clubs, and other community information centers.

10.7 LIST OF REPOSITORIES

Winthrop Public Library
Attn: George Pillion
2 Metcalf Square
Winthrop, MA 02152
846-1703

Hours of service: Mon., Tues., Thurs. 1-9; Wed. 10-9; Fri. 10-6; Sat. 10-5

Thomas Crane Public Library
Attn: Linda Beeler--Reserve Dept.
40 Washington Street
Quincy, MA 02169
471-2400

Hours of service: Mon.-Thurs. 9-9; Wed. 10-9; Fri. 10-6; Sat. 10-5

Hough's Neck Community Center
Attn: Patricia Redlen
1193 Sea Street
Quincy, MA 02169

Hours of service: Mon. 9-8:30; Tues.-Fri. 9-4

State House Document Room
Attn: Jennifer Nason
Document Dept./Rm. 341
State House
Boston, MA 02133
727-2590

Hours of service: Mon.-Fri. 9-5

Wellesley Public Library
530 Washington Street
Wellesley, MA 02181

Hours of service: Mon.-Thurs. 10-9; Fri. 10-7; Sat. 9-5; Sun. 2-5

Malden Public Library
Walpole Street
Malden, MA 02062

Hours of service: Mon.-Fri. 9-9; Sat. 9-5; Sun. 1-5

MWRA Library
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129
242-6000

Hours of service: Mon.-Fri. 8:30-5

(This is a central reference location with full project histories and other information available to CAC members and the public.)

10.8 MAILING LIST

The MWRA's computerized mailing list currently consists of over 2,000 individuals, groups and agencies, which fall into the following categories:

- o MWRA Advisory Board (local officials of the service district)
- o Legislators (federal, state, regional, local)
- o Media
- o Agencies (federal, state, regional, local)
- o Groups/Organizations
- o Individuals

In addition, issue codes have been assigned to mailing list entries, so the list may be sorted by issue code, zip code, or city/town. Attendees at public meetings are added to the mailing list.

10.9 PUBLIC PARTICIPATION SCHEDULE

The CAC meeting agenda is reviewed with the chairman and executive committee of the CAC prior to each meeting. The long-term agenda is reviewed with the CAC on a quarterly basis and updated as needed, with their input. For a complete listing of meetings that have taken place and planned meetings, please refer to the Public Participation Schedule (Table 10.9-1).

TABLE 10.3-1
STFP
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES

Lois Baxter
17 Circuit Road
Winthrop, MA 02152
Alternate
846-3040 (h)

William Benson
52 Grinnell Street
Greenfield, MA 01301
Representative
(413) 773-5267

Peter Blanchard
Mass. Bankers Association
Prudential Tower, Suite 550
Boston, MA 02199
Representative
542-1837

Mike Brother
USGS
Quisset Campus
Woods Hole, MA 02543
Alternate
548-8700

Polly Bradley
SWIM
33 Summer Street
Nahant, MA 01908
Representative
581-0075

Brad Butman
USGS
Quisset Campus
Woods Hole, MA 02543
Representative
548-8700

TABLE 10.3-1
STFP
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES
(Continued)

Eugene Canty
2 Lafayette Terrace
Nahant, MA 01908
Alternate
581-0281

Michael Cheney
94 Rock Island Road
Quincy, MA 02169
Alternate
471-1493

Joseph F. Conoby
Honeywell Bull, Inc.
300 Concord Road
Billerica, MA 01821
Representative
671-3614

Sharon Dean
N. E. Aquarium
Central Wharf
Boston, MA 02110
Representative
973-6552

Clifford deBuan
Sierra Club New England
1386-A Canton Ave.
Milton, MA 02186
Alternate
333-0173

TABLE 10.3-1
STFP
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES
(Continued)

Leonard DeModena
182 Pinceton Street
East Boston, MA 02128
Representative
727-1263 (w)

Emilie DiMento
Winthrop Concerned Citizens
118 Woodside Ave.
Winthrop, MA 02152
Representative
826-9406

Mark Doran
Associated Industries of Mass.
462 Boylston Street
Boston, MA 02116
Representative
262-1180

Joe Duggan
Greater Boston Chamber of Commerce
125 High Street
Boston, MA 02110
Representative
426-1250

William Elliott
2 Bargate Lane
Hadley, MA 01035
Representative
(413) 586-8861

TABLE 10.3-1
STFP
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES
(Continued)

Astrid Glynn
Glynn & Dempsey, P.C.
One Federal Street
Boston, MA 02110
Representative
523-7420

Phillip Goodwin
Mass. Bay Yacht Clubs Assoc.
73 Bicknell Street
Quincy, MA 02169
Representative
471-5913

Alice Hennesey
Boston City Council
One City Hall Plaza
Boston, MA 02201
Alternate
725-4000

Stephen Hunt
Save the Harbor/Save the Bay
3 Joy Street
Boston, MA 02108
Alternate
742-7283

Betsy Johnson
Mass. Audubon - Boston
3 Joy Street
Boston, MA 02108
Representative
367-1026

TABLE 10.3-1
STFP
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES
(Continued)

Ruth Kaminski
25 Moosehill Road
Leicester, MA 01524
Representative
892-3121

Mary Kelley
Winthrop Conservation
Commission
48 Sargent Street
Winthrop, MA 02152
Representative
846-9450

Robert Luongo
Office of Community Development
City Hall, 500 Broadway
Chelsea, MA 02150
Alternate
889-0700

Joseph MacRitchie
110 Sonoma Road
Squantum, MA 02171
Representative
773-1380

Tom McNiff
118 Grandview Ave.
Winthrop, MA 02152
Alternate
846-3782

Herbert Meyer
Mystic River Watershed Assoc.
276 Massachusetts Avenue
Arlington, MA 02174
Representative
643-2157

TABLE 10.3-1
STFP
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES
(Continued)

Phil Mitchell
Construction Industries of Mass.
P.O. Box 667
Norwood, MA 02062
Alternate
551-0182

Martin Nee
c/o Rep. M. Flaherty
State House, Room 138
Boston, MA 02133
Representative
722-2396

Robert Noonan
Winthrop Board of Selectmen
Town Hall
Winthrop, MA 02152
Representative
846-1852

Marjorie O'Neil
212 Chestnut Street
Brookline, MA 02146
Alternative
232-6260

John Piotti
MWRA Advisory Board
6 Beacon St., Room 925
Boston, MA 02108
Representative
742-7561

TABLE 10.3-1
STFP
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES
(Continued)

Stewart Sanders
Mystic River Watershed Assoc.
73 Fairmont Street
Belmont, MA 02178
Alternate
489-3120

John Scalcione
36 Frankfort Street
East Boston, MA 02128
Representative
589-3926

Lawrence Schafer
26 Emerson Street
Newton, MA 02158
Representative
965-9888

Judith Schlosser
Office of Community Development
City Hall, 500 Broadway
Chelsea, MA 02150
Representative
889-0700 (w)

Eric Thomas
Utility Contractors' Association
150 Wood Road, Suite 305
Braintree, MA 02184

Jack Walsh
63 Sea Avenue
Quincy, MA 02169
Representative
471-6191 (h)

TABLE 10.3-1
STFP
CITIZENS' ADVISORY COMMITTEE
REPRESENTATIVES AND ALTERNATES
(Continued)

Virginia Wilder
Office of Community Development
Town Hall
Winthrop, MA 02152
Alternate
846-1852

Nicholas Yannoni
31 Lafayette Road
Newton, MA 02162
Alternate
377-2206

TABLE 10.4-1
STFP
TECHNICAL ADVISORY GROUP

Karen Adams
US Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02154
TAG
647-8237

Libby Blank
Boston Water and Sewer Commission
10 Post Office Square
Boston, MA 02109
TAG
426-6046

Susan Bregman
Boston Traffic and Parking
Boston City Hall
Boston, MA 02201
TAG
565-3549

Leigh Bridges
Dept. of Fisheries, Wildlife & Env. Enf.
100 Cambridge Street, 19th Floor
Boston, MA 02202
TAG
727-3193

Eric Buehrens
Department of Environmental Mgmt.
225 Friend Street
Boston, MA 02114
TAG
727-3160

Ken Carr
US Fish & Wildlife Service
P.O. Box 1518
Concord, NH 03301
TAG

TABLE 10.4-1
STFP
TECHNICAL ADVISORY GROUP
(Continued)

Roberta Ellis
MASSPORT Planning Department
10 Park Plaza
Boston, MA 02116
TAG
973-5390

David Graber
118 Larson Road
Stoughton, MA 02072
TAG
341-0390

Fred Hoskins
Executive Office of Economic Affairs
1 Ashburton Place
Boston, MA 02108
TAG
727-8380

Steve Lipman
DEQE/DWPC
One Winter Street
Boston, MA 02108
TAG
292-5698

Christopher Mantzaris
US Nat'l Marine Fisheries Serv.
14 Elm Street
Gloucester, MA 01930
TAG

Julia O'Brien
MDC Planning Office
20 Somerset Street
Boston, MA 02108
TAG
727-9693

TABLE 10.4-1
STFP
TECHNICAL ADVISORY GROUP
(Continued)

William Patterson
US DOI, Off. of Env. Proj.
Review
15 State Street
Boston, MA 02109
TAG
223-5517

Myra Schwartz
BRA, Harbor Planning and
Develop.
1 First Ave., 2nd Floor
Charlestown, MA 02129
TAG
242-2282

Brona Simon
Massachusetts Historical Commission
80 Boylston Street
Boston, MA 02216
TAG
727-8470

Linda Smith
BRA, Harbor Planning
1 First Ave., 2nd Floor
Charlestown, MA 02129
TAG
242-2282

Jan Smith
Office of Coastal Zone Mgmt.
100 Cambridge Street, 20th
Floor
Boston, MA 02202
TAG
727-9530

TABLE 10.4-1
STFP
TECHNICAL ADVISORY GROUP
(Continued)

David Standley
Center for Environmental Mgmt.
Curtis Hall, Tufts, University
Medford, MA 02155
TAG
381-3486

Mike Tierney
Exec. Office of Communities & Development
100 Cambridge Street, 14th Floor
Boston, MA 02202
TAG
727-7765

Dave Tomey
US EPA
JFK Federal Bldg, Rm. 2100 B
Boston, MA 02203
TAG
565-3552

Lt. Commander Michael Wade
U.S. Coast Guard, Marine Safety Div.
477 Commercial Street
Boston, MA 02109
TAG
223-8441 (Douglas Brown)

Kim Zullo
MASSPORT Development Dept.
10 Park Plaza
Boston, MA 02116
TAG

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1986-1987

Project/ Activity	October	November	January	February
CAC Meeting	10/27 Intro.	11/24 Public Participation Workplans	1/5 Mitigation commitments and planning; Conceptual Site Layouts (Harbor Perspectives); Flows and Loads (preliminary)	2/2 Flows and Loads Environmental Scoping
General CAC Issues		CAC Organization Chairperson Selection		Agenda review next quarter

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1986-1987
(Continued)

Project/ Activity	October	November	January	February
Sub Committees				2/2 Scoping
Community Meetings Hearings & Forums			2 Community meetings (STFP Harbor Perspectives); Winthrop 12/18 & Quincy 1/15	Forum 1/22
Distribution of Materials		Harbor Perspective Report		Draft reports: - Flows and Loads - Environmental Review Scope

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1987
(Continued)

Project/ Activity	February	March	April	May
CAC Meeting	2/23 Discuss Flows & Loads (WWTP size); Outfall; Environmental Scope	3/23 Draft reports: - Outfall - Evaluation Criteria	4/27 Outfall; Power; Site Development	6/1 Special Meeting: - Site Tour - Site Layouts
General CAC Issues			Agenda review	

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1987
(Continued)

Project/ Activity	February	March	April	May
Subcommittees	Outfall siting	Evaluation Criteria 3/19 & 3/31 Outfall 3/10 & 3/20	Outfall 4/16	
Community Meetings Hearings & Forums		2 Public Meetings Outfall; (Siting & Technology Screening); Quincy 3/12 & Lynn 3/18	2 Community workshops (Site Layout); Winthrop 4/22 & Quincy 4/30	
Distribution of Materials	Drafts: - Evaluation Criteria - Outfall Siting			

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1987
(Continued)

Project/ Activity	June	July	August	September
CAC Meeting	6/29 EPA EIS Outfall Criteria Historical & Archaeological; Site Preparation	7/27 Outfall; Detailed Evaluation of Alternatives	8/24 Preliminary Implementation Schedule; Outfall	9/28 Outfall; Implementation Schedule; DEIR/EID
General CAC Issues		Agenda Review		

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1987
(Continued)

Project/ Activity	June	July	August	September
Subcommittees	Outfall Siting Criteria	Treatment Processes; Site Layouts; Vol. II; Outfall	Outfall Inter-Island (Vol. IV)	
Committee Meetings Hearings & Forums Inter-Island		2 Committee Workshops. Site Preparation/ (Outfall) N.&S. Public Meeting Boston, 7/22 (Site Preparation Inter-Island)		2 Committee Workshops. (Outfall) N. & S. Shore 1 Public Meeting (FP/EIR recommendations.)
Distribution of Materials	Evaluation Criteria (non-outfall)	Tech. Memo: Treatment Processes. & Site Layouts	Tech. Memo.: Estimated Costs; Draft Vol. II Status Report Mitigation	Status Report: Implementation schedule Draft Vol. IV*

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1987-1988
(Continued)

Project/ Activity	October	November	December	January
CAC Meeting	Draft Facilities Plan Environmental Review Vol III* Vol IV* Vol V* Treatment Plant Performance	Facilities Plan Environmental Review	Facilities Plan Environmental Review	Facilities Plan Environmental Review
General CAC Issues	Agenda review			Agenda review

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1987-1988
(Continued)

Project/ Activity	October	November	December	January
Subcommittees				
Committee Meetings/ Hearings & Forum	Public Hearing (3 locations, Vols. II, IV, & VI)*	Facilities Plan/EIR Hearing (3 locations, Vols. I, III, & VII)* 2 Outfall Public Meetings		Forum Outfall Hearing (3 locations, Vol. V)*
Distribution of Materials	Draft Vol. I* Draft Vol. III* Draft Vol. V* Draft Vol. VII* Final Vol. VI* Draft Miti- gation	Supplemental Vol. V*	Final Vol. II* FInal Vol. IV*	

TABLE 10.9-1
PUBLIC PARTICIPATION SUMMARY
MEETINGS FOR 1988
(Continued)

Project/Activity	February	March	April	May
CAC Meeting	Facilities Plan Env. Review			
General CAC Issues				
Subcommittees				
Committee Meetings/ Hearings & Forum				Forum
Distribution of Materials	Final Vol. I* Final Vol. III* Final Vol. V* Final Vol. VII*			

*Key to Volumes:

Vol. I	-	Executive Summary
Vol. II	-	Planning Background - Flows & Loads, Water Quality, Waste Characterization
Vol. III	-	Treatment Plant
Vol. IV	-	Inter-Island Conveyance System
Vol. V	-	Outfall
Vol. VI	-	Early Site Preparation
Vol. VII	-	Institutional Considerations

WATER RESOURCES AUTHORITY
MASSACHUSETTS